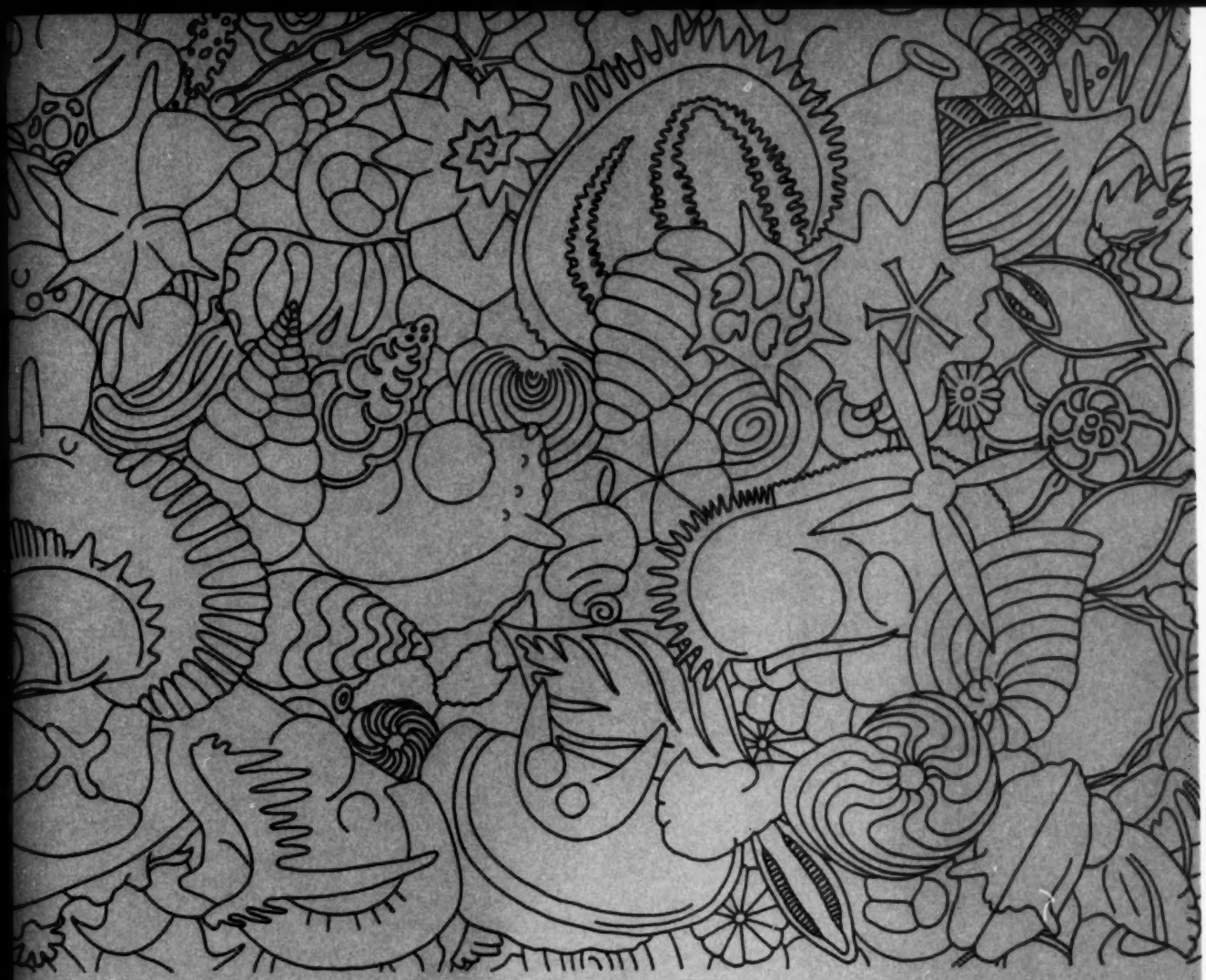


micropaleontology

volume 3
number 3

july 1957

PUBLISHED BY:

Department of Micropaleontology
American Museum of Natural History
Central Park West at Seventy-Ninth Street
New York 24, New York

micropaleontology

volume 3
number 3
July
1957

articles

A study of the morphology and variation of some Upper Lias foraminifera ..... G. C. ADAMS 205

New calcareous algae from the Arabian Peninsula ..... GRAHAM F. ELLIOTT 227

Oligo-Miocene Ostracoda from southern Trinidad ..... W. A. VAN DEN BOLD 231

The nomenclatural problem of plant microfossil species belonging to extant genera ..... ALFRED TRAVERSE 255

Occurrence of *Nezzazata* in Israel ..... Z. REISS 259

Annotated bibliography of micropaleontology in France, 1952–1956 (exclusive of foraminifera and Ostracoda) ..... GEORGES DEFLANDRE 263

Carl A. Wicher – 1901-1957 ..... HELMUT BARTENSTEIN 268

Die Gattung *Gomphocythere* in Nordwestdeutschland und das Problem der brackischen Ostracoden ..... G. A. WICHER 269

Pollen and spore formulae – A suggestion ..... ROBERT H. TSCHUDY 277

Occurrence of *Clypeina* in the Eocene of Florida ..... RICHARD REZAK 281

Bibliography of ostracode theses ..... LOUIS S. KORNICKER 287

A new method of recovering remains of the chitinous integument of fossil Ostracoda ..... GERALD P. R. MARTIN 291

Charophyta-bearing chert from New England stream beds ... WARREN I. JOHANSSON 293

The "Zoological Record" ..... ROBERT H. CUMMINGS 295

news reports

Germany ..... HEINRICH HILTERMANN 296

Japan ..... KIYOSHI ASANO 297

North Africa ..... JEAN MAGNÉ 298

The subscription price of this quarterly is $8.00 per year. Single copies are $2.50 each.

ABSTRACT: *This paper gives an account of the morphologic variation and dimorphism shown by certain species of foraminifera belonging to the family Lagenidae in the Upper Lias of northern Lincolnshire, England. The variation of the megalospheric generation is described, and the relative importance of different morphological features commonly used in the diagnosis of species is discussed. The clear morphologic separation of microspheric and megalospheric generations is established in one case, but no support for the theory of trimorphism is given by this investigation.*

A study of the morphology and variation of some Upper Lias foraminifera

G. C. ADAMS
King's College
University of London

INTRODUCTION

This communication forms part of a general study of the Upper Lias foraminifera of northern Lincolnshire, England, the results of which are contained in an unpublished Ph.D. thesis written at the University of Nottingham in 1955. A paper incorporating a systematic description of the whole foraminiferal fauna is at present being prepared. The original work showed that many Liassic species and genera of the family Lagenidae exhibit great morphologic variation, a fact recognized by most previous workers, and the present paper seeks to analyse this variation in a number of cases.

In the author's opinion, studies of the morphologic variation shown by members of a community are of more importance in modern paleontology than the compilation of species lists, which may not reflect the true interrelationships of the fauna. A multiplicity of specific names often tends to obscure the close affinity of individuals which may be potentially interbreeding members of a community. A better understanding of the evolution of a group and of the problems involved in species differentiation will be reached if each assemblage of individuals showing gradation in their morphology is treated as an evolving plexus. An attempt has thus been made to analyse the variation shown by some lagenid plexuses, rather than to list a number of arbitrarily defined species.

Where an assemblage of lagenids appears to include groups of two or more closely related species, the biocharacters on which those species were founded have been examined, and all the members of a grading series are regarded as belonging to a single species where gradation between these characters has been established. Exceptions are made for those forms where gradations are merely between extreme variants of two species groups, and where other characters of definitive importance have been found. Such exceptions will be described in a subsequent paper.

In many early studies of the family Lagenidae, species have been erected on solitary or rare megalospheric individuals, an understandable error when the alteration of generations was unknown. However, in much of the literature, including some of that more recently published, new species are described with no regard to the variation shown by the species group as a whole. When microspheric specimens are lacking, identification is necessarily based on their megalospheric counterparts, even though the latter may be highly variable. Nevertheless, even in an assemblage comprised of two or more species, the megalospheric forms of which intergrade, measurements of the definitive biocharacters, e.g., number of ribs, degree of coiling, overlap of chambers, etc., should reveal the presence of more than one species when plotted on distribution diagrams. The modal position of each species should be distinctive, although some overlapping will occur. It is, of course, possible that end members of a plexus that have previously been regarded as distinct species may merit specific rank at other horizons or in

different localities. An incidental result of such studies is that the tendency to regard recurrent homeomorphs as long-ranging species is avoided.

In addition to the foregoing, an attempt has been made to determine whether or not any species exhibits trimorphism. The relationships, if any, between dimorphism and variation have also been investigated.

The present paper is intended to show how some genera and species varied within a small area throughout a relatively short period of time. Although the conclusions reached may be valid only for this area, a number of such studies in other areas will, it is hoped, lead to a more complete understanding of the variation and evolution of the family Lagenidae.

The author is indebted to Professor W. D. Gill, Trinity College, Dublin, and to Dr. J. E. Prentice, King's College, London, for reading the typescript and for offering much helpful advice. Thanks are also due to the University of Nottingham for the award of a Revis Studentship, during the tenure of which this work was undertaken.

HISTORICAL REVIEW

The only recent work on the Liassic Lagenidae of Britain has been carried out by Macfadyen (1941) and by Barnard (1950*a*, 1950*b*, 1956). Most of this work concerns type and homoeotype material only, but the latter author has studied variation in some genera, notably *Planularia* and *Pseudoglandulina*. His comprehensive work on the Lagenidae of the Lias is awaited with interest. The microfauna of the Lias of northern Lincolnshire has not been studied hitherto.

Many authors have commented on the difficulties encountered when trying to classify members of the Lagenidae, owing to their extreme variability (Cushman, 1940; Glaessner, 1945; Bartenstein, 1948*a*, *b*, *c*, etc.), and Bartenstein (1948*a*, *b*, *c*) has attempted to resolve some of the nomenclatural confusion that exists. Brotzen (1953) has suggested a new method of classifying the Lagenidae based on the supposed "constant characters" of Triassic and Jurassic genera. This method would involve the introduction of a large number of new generic names, at least fifty-six generic names being required for the uniserial rectilinear types alone. The two basic characters which Brotzen believes to be constant are (a) the shape of the test in cross-section; and (b) the presence or absence of costae.

It has been the experience of the present author that these characters are not always constant even within the limits of a single species. The genus *Dentalina* serves to illustrate this. *Dentalina tenuistriata* Terquem is a commonly occurring Lias species, and in the large amount of material possessed by the author is always markedly costate, that is to say, it possesses numerous fine ribs which on no specimens show any sign of reduction. *Dentalina primaeva* d'Orbigny, on the other hand, shows all stages of costation from a well-ribbed form at one extreme to a completely smooth form at the other. In the first case the presence of ribs is a diagnostic feature of the species, whilst in the second it is not. Similar examples could be cited from other lagenid genera, such as *Frondicularia*, *Lingulina*, and *Astacolus*, to mention but a few.

Nor is Brotzen on safe ground when he deals with the cross-sectional shape of the test. The genera *Lenticulina* and *Astacolus* grade into one another as do *Astacolus* and *Planularia;* similarly, *Marginulina*, *Dentalina*, and *Vaginulina* are variable, and any attempt to separate them on the cross-sectional shape of the test alone, save in the most arbitrary fashion, seems impossible. It may perhaps be said that if the problem of the nomenclature of the Mesozoic lagenids is ever satisfactorily solved it will be by means of variation studies of the earlier plexuses and not by the application of a terminology based on their later, perhaps more stable, descendants.

PREPARATION OF MATERIAL AND WORKING METHODS

The foraminifera used in this study all came from a cored bore-hole situated at Risby-Warren near Scunthorpe, Lincolnshire. The core included 57 feet of Upper Lias shale, representing the *Dactylioceras tenuicostatum* and *Harpoceras falcifer* zones. The whole of the Upper Lias in this area is known to belong to these divisions, and zonal ammonites were obtained from this particular core. Identifications of ammonites were carried out by the Geological Survey of Great Britain, and the specimens remain in their keeping. The types and figured specimens of the foraminifera are deposited in the collections of the British Museum (Natural History) (B.M.N.H.), London.

The cored material was divided into one-foot lengths and its lithology noted. The only variations appeared to be in hardness and in mica content, the lowest 6 feet being very soft and micaceous. In view of the thickness of shale comprising each sample (one foot), it cannot be claimed that the contained foraminifera represent a single community, but,

owing to the condition of the core, it was impossible to deal with smaller divisions. It is therefore acknowledged that the variation seen amongst specimens in a given sample did not necessarily exist amongst a single living community, although even that is not impossible, as only a minute area is considered; nevertheless, it all must have occurred within a relatively short span of geologic time.

Each sample comprised about one and a half pounds of shale, which was disaggregated by the usual methods, the residue being collected on four sieves of different sizes, the finest being 200 mesh. Specimens were carefully collected by hand, nothing being ignored except for the very immature stages of large species, such as *Marginulina prima* d'Orbigny, which collected on the 200-mesh sieve. All subjective selection was thereby avoided.

Only species showing considerable variation and represented by numerous individuals are dealt with here. Thus, out of some seventy species of Lagenidae identified, only six fulfilled these conditions. In some cases, e.g., *Planularia*, where direct comparison of specimens was necessary, it was found useful to photograph all the specimens on a Vickers projection microscope and to work with the resulting prints.

MORPHOLOGY AND VARIATION

The most variable and readily studied species were those belonging to the genera *Planularia* Defrance, *Falsopalmula* Bartenstein, *Marginulina* d'Orbigny, *Frondicularia* Defrance, and *Lingulina* d'Orbigny. With the exception of *Frondicularia* these are all discussed below.

SYSTEMATIC DESCRIPTIONS

Order FORAMINIFERA

Family LAGENIDAE

Genus **Planularia** Defrance, 1824

Representatives of this genus occur abundantly throughout the core. They are present at all levels but are especially numerous in the upper part. A number of immature specimens were found in each sample, but it was impossible to decide whether these should be referred to *Planularia* or *Falsopalmula*, as the young stages of these genera are identical and the two occur together. The greatest degree of variation is seen, as might be expected, where the specimens are most abundant, and a careful study has been made of the population at those levels.

An important feature of every assemblage is the marked lack of microspheric forms. At some levels these are entirely absent, a phenomenon which it is difficult to explain. The large amount of variation which occurs is therefore virtually limited to megalospheric forms, a factor which probably accounts for the large number of specific names which have in the past been assigned to this group.

From time to time authors have recorded different morphological features, or combinations of features, as being of diagnostic importance in the identification of species of *Planularia* and *Falsopalmula*. An attempt has been made to assess the value of these characters when applied to the present material. Over 1000 specimens were examined.

The following characters have, at various times, been considered of diagnostic value in delimiting species of *Planularia:* Size of test; degree of initial coiling; angle made by later sutures with the peripheral wall; presence of ribs or striations; shape of individual chambers; shape and size of proloculum; and amount of lateral compression of the test.

Size of test: At first sight, variation in the size of the test might appear to constitute a good criterion of species, and indeed it may sometimes do so. Obviously, there is an optimum size to which the individuals of a species will grow in a particular environment when the conditions therein remain constant. Equally clearly, if conditions in the environment change slightly, the maximum size attainable by the individuals of the same species might be increased or decreased. Such environmental changes may or may not be reflected in slight lithologic changes within the sediments, and if such changes do occur, then changes in test size are not surprising.

The appearance of the material used in this investigation seems to suggest that test size is affected by environment, but as similar specimens have not been compared from different localities, nothing can yet be proved. The observed changes in size primarily affect genera other than *Planularia*, e.g., *Marginulina*, where a change in the lithology of the sediments seems to be reflected in the abundance and size of the tests present. This lithologic change is slight, merely an alteration from soft micaceous shale to somewhat harder non-micaceous shale. The presence or absence of the mica itself has no direct connection with the condition of the fauna, for mica-rich shales are known with both rich and impoverished faunas. However, in this case the sudden change to non-micaceous shale may reflect some local fluctuation in conditions, other aspects of which could account for the changes.

On the whole, not much information was obtained with regard to variation in test size in the case of *Planularia*. It can only be stated that individuals tended to be of a larger size toward the bottom of the section sampled (i.e., in the micaceous shale) than they were at the top. Unfortunately, only a small number of specimens occurred in the lower part of the section.

Degree of initial coiling: A characteristic feature of the genus is that all its members either possess an initial coil or show an initial tendency to coil. Microspheric forms are, without exception, coiled. Measurements of the amount of coiling have been made by counting the number of chambers that are in contact with the proloculum, or that overlap the proloculum and touch the second chamber. This method has a disadvantage in that it reflects only the degree of curvature of the inner side of each chamber. The outer side may be equally curved or completely evolute. Whilst there is no theoretical upper limit to the number of chambers in a coil (save that it cannot exceed the total number of chambers in the test), the lower limit is, of course, two. Text-figure 1a shows a series of forms that grade from an initially close-coiled individual (no. 1) to a virtually uncoiled specimen (no. 5). The graph below indicates the number of specimens of each type present in the sample, and it is clear that the close-coiled and uncoiled individuals are end members of a continuously grading series, typical members of which are centrally situated on the graph. Text-figure 1b indicates variations in the width of the test at the same level amongst specimens that are equally coiled. In this case three "species" could possibly be recognized: *Planularia pauperata* (Jones and Parker) (nos. 1 and 2), *Planularia pseudocrepidula* Adams, n. sp. (= *Planularia crepidula* (Fichtel and Moll) of most workers on the Lias) (nos. 3 and 4), and *Planularia protracta* (Bornemann) (nos. 5 and 7). These two series illustrate the variations that may occur when one feature of the morphology is regarded as constant. However, in practice it has not been possible to find any constant features, so that the resulting possibilities of variation in shape within any assemblage are enormous.

The remaining morphological features are dealt with under *Falsopalmula*, a genus closely related to *Planularia*.

Planularia pseudocrepidula Adams, **new species**
Text-figures 1–5

Cristellaria crepidula (Fichtel and Moll). – Blake, 1876, Yorkshire Lias, p. 466, pl. 17, fig. 25; pl. 19, figs. 12, 14, 15. – Franke, 1936, Preuss. Geol. Landesanst., Abh., new ser., no. 169, p. 95, pl. 9, figs. 22, 23a–b. –Bartenstein and Brand, 1937, Senckenb. Naturf. Ges., Abh., no. 439, p. 169, pl. 3, fig. 48; pl. 4, fig. 76; pl. 5, fig. 74; pl. 9, fig. 45a–c.

?Cristellaria crepidula (Fichtel and Moll). – Brady, 1867, Somersetshire Archaeol. Nat. Hist. Soc., Proc., vol. 13, pt. 2, p. 228, pl. 3, fig. 39. – Issler, 1908, Palaeontographica, vol. 55, p. 79, pl. 5, figs. 244–248.

Not *Nautilus crepidula* Fichtel and Moll, 1798, Test. Micr., p. 107, pl. 19, figs. g–i.

Diagnosis: Test highly compressed, thin and glassy in appearance, consisting of up to twelve chambers, of which the first few normally form an initial coil; later chambers become evolute on the peripheral side, but on the ventral side tend to reach downward toward the coil. Sutures narrow, flush or slightly deepened at the surface. Proloculum variable in shape, commonly either subspherical or oval. Aperture terminal, situated at the peripheral edge of the last chamber.

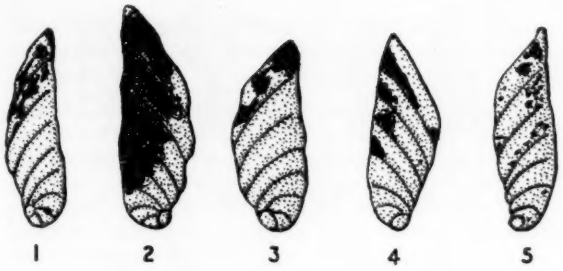
Dimensions: Maximum length 0.71 mm.; maximum width 0.23 mm.

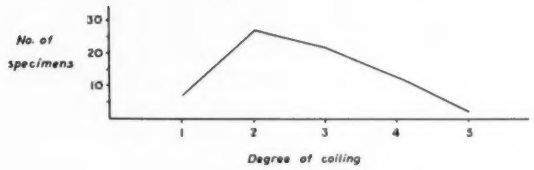
Variation: This species is extremely variable, especially in size, shape, and degree of coiling (details are given below). It appears to grade into and be inseparable from *Planularia pauperata* (Jones and Parker), *Planularia protracta* (Bornemann), and *Planularia filosa* (Terquem), although at least the first two of these seem to be readily

---

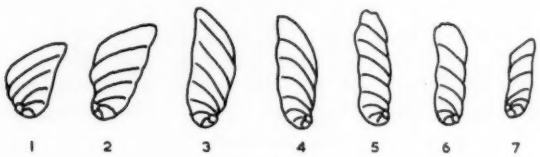
TEXT-FIGURES 1–4

1a (1–5), *Planularia pseudocrepidula* Adams, n. sp., series showing variation in degree of coiling at one level, all × 60; the graph below shows the number of individuals in the sample which have the same degree of coiling; the numbers on the graph correspond with those of the specimens above; all the specimens are megalospheric. 1b (1–7), *Planularia pseudocrepidula* Adams, n. sp., a grading series of individuals, all of which have the same amount of initial coil, all × 40; in this case the width varies; all the specimens are megalospheric and are from the same level as those in text-figure 1a. 2, *Planularia pseudocrepidula* Adams var. *robusta* Adams, n. var., six typical specimens, all megalospheric, all × 47. 3, *Planularia pseudocrepidula* Adams, n. sp.; a, variation at 26–27 feet (all megalospheric, all × 50); the specimens resemble the following "species": 1–4, *Planularia crepidula* (Fichtel and Moll) of various authors; 5–7, *Planularia protracta* (Bornemann) of various authors; 8–10, *Planularia dorsoarcuata* (Wiśniowski) of various authors; 12–13, *Planularia anceps* (Terquem) of various authors; b, variation at 22–23 feet (all × 50): 6–9, *Planularia dorsoarcuata* (Wiśniowski) or *Planularia filosa* (Terquem) of various authors; c, variation at 16½ to 17½ feet (all × ca. 47) (see also text-fig. 5a): 1–5, *Planularia pseudocrepidula* Adams var. *robusta* Adams, n. var. 4, graphs showing the differences in the number of chambers developed by *Planularia pseudocrepidula* and *Planularia pseudocrepidula* var. *robusta*.

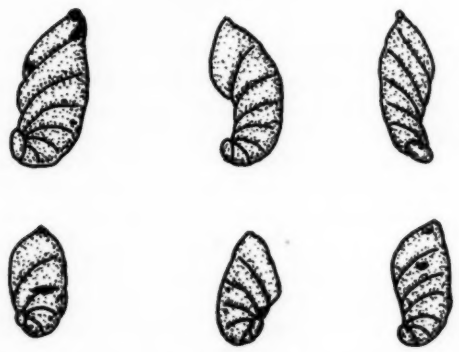




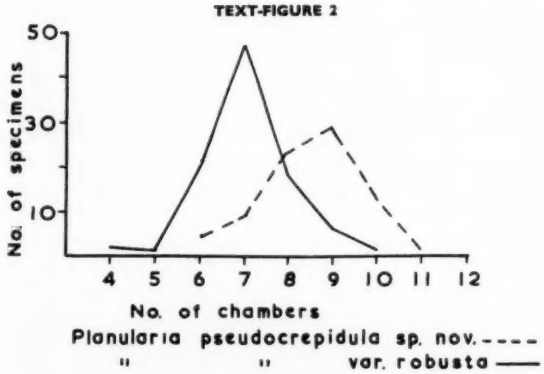
TEXT-FIGURE 1a



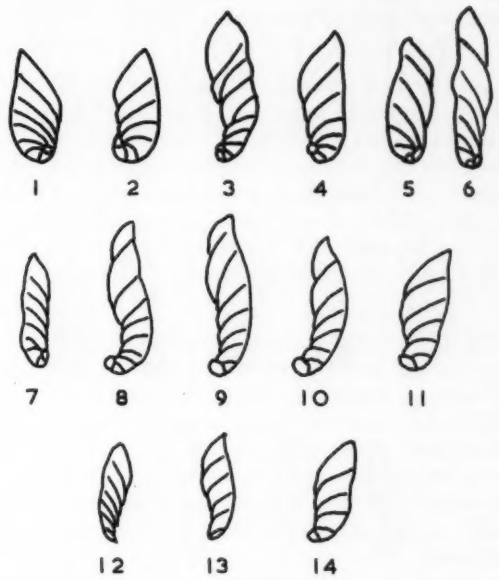
TEXT-FIGURE 1b



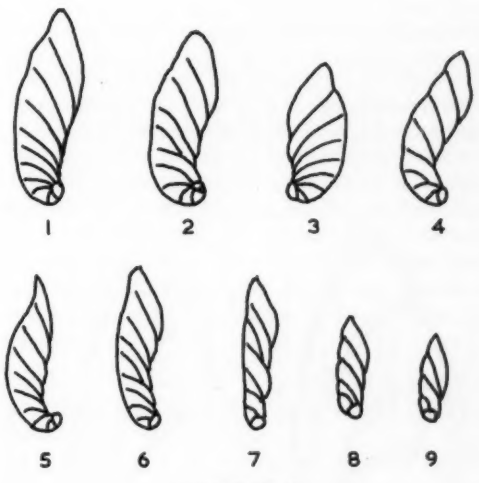
TEXT-FIGURE 2



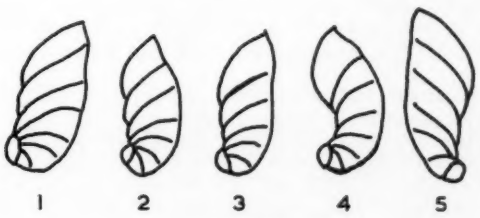
TEXT-FIGURE 4



TEXT-FIGURE 3a



TEXT-FIGURE 3b



TEXT-FIGURE 3c

TEXT-FIGURE 5a

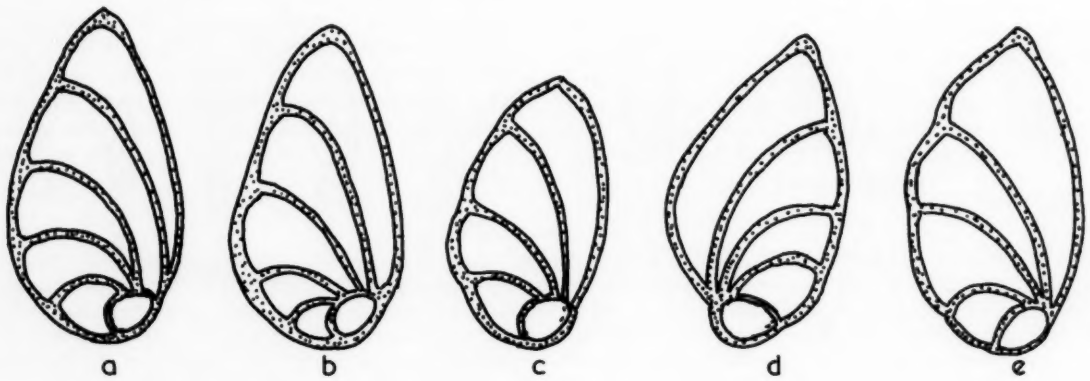
TEXT-FIGURE 5b

TEXT-FIGURE 5c

TEXT-FIGURE 5d

TEXT-FIGURE 5

Planularia pseudocrepidula Adams, n. sp., all × ca. 46; a, variation at 16½ to 17½ feet (continued): 12–13, typical uncoiled forms of a type that has often been referred to *Vaginulina*; b, variation at 14½ to 15½ feet; of these specimens, no. 6 could be referred to the "species" *Planularia anceps* (Terquem); c, variation at 10½ to 11½ feet; these are some of the smaller forms at this level; see text-figures 1a and 1b for more typical individuals; d, variation at 9–10 feet: 1–3, typical specimens of *Planularia pseudocrepidula*.



TEXT-FIGURE 6

Five small specimens of *Planularia* (or *Falsopalmula?*) from the upper part of the section. Similar specimens have been recorded as *Cristellaria gracilis* Kübler and Zwingli, *Cristellaria argovensis* Kübler and Zwingli, *Cristellaria parkinsoni* Kübler and Zwingli, *Cristellaria mitra* Kübler and Zwingli, and *Cristellaria semi-involutina* Terquem var. *plana* Deecke; they are, however, clearly young stages of either *Planularia* or *Falsopalmula*. It is significant that all such specimens are megalospheric.

identifiable in some districts. Its young stages are indistinguishable from those of *Falsopalmula deslongchampsi* (Terquem).

Remarks: Planularia pseudocrepidula is a very common Lias species over the whole of western Europe. In northern Lincolnshire it is found throughout the Upper Lias. Previous authors have referred its representatives to *Cristellaria crepidula* (Fichtel and Moll), which was, however, originally described from Recent material, and which, in any case, is the type species of *Astacolus* Montfort, 1808. It is much longer, more robust, and less compressed than the Lias form here under consideration. The name "*pseudocrepidula*" has been chosen because it immediately recalls the older name which has so often been used in error.

Types: Holotype, B.M.N.H. no. P.43374. Paratypes (four specimens), B.M.N.H. no. P.43375.

Material: Approximately 400 specimens from the Upper Lias of northern Lincolnshire.

Variation in successive communities in the Upper Lias of northern Lincolnshire: The variation was studied in every sample that yielded sufficient specimens. The numbers given below refer to the depth of the sample below the top of the Upper Lias, a horizon which was itself 80 feet below ground level. It is clear that the range of variation is not uniform at all horizons, the principal variants tending to differ in number and in type from one horizon to another.

In the lower part of the succession the specimens are neither numerous nor very variable. All the individuals begin with an initial coil. A few specimens occur which closely resemble *Planularia pauperata* (Jones and Parker) in shape, but as they are outside the normal range of variation exhibited by *Planularia pseudocrepidula* elsewhere in the section, they are best referred to the former species.

Above 29 feet, specimens become more numerous and are especially abundant at some levels, where the variation has been studied in detail. At intermediate horizons, specimens are less numerous and always occur together with *Falsopalmula*, so that most of them are probably young stages of a species of that genus.

At 26–27 feet, microspheric forms are very rare. The range of morphology is illustrated in text-figure 3a. The initial coil is usually rather weak, and quite a large number of specimens are almost completely uncoiled. All the specimens illustrated are megalospheric and might have been ascribed by earlier workers to the following species:

Nos. 1–4: *Planularia crepidula* (Fichtel and Moll);
Nos. 5–7: *Planularia protracta* (Bornemann);
Nos. 8–10: *Planularia dorsoarcuata* (Wiśniowski);
Nos. 12–13: *Planularia anceps* (Terquem).

The general tendency here is for individuals to be longer and narrower than the typical *Planularia pseudocrepidula.*

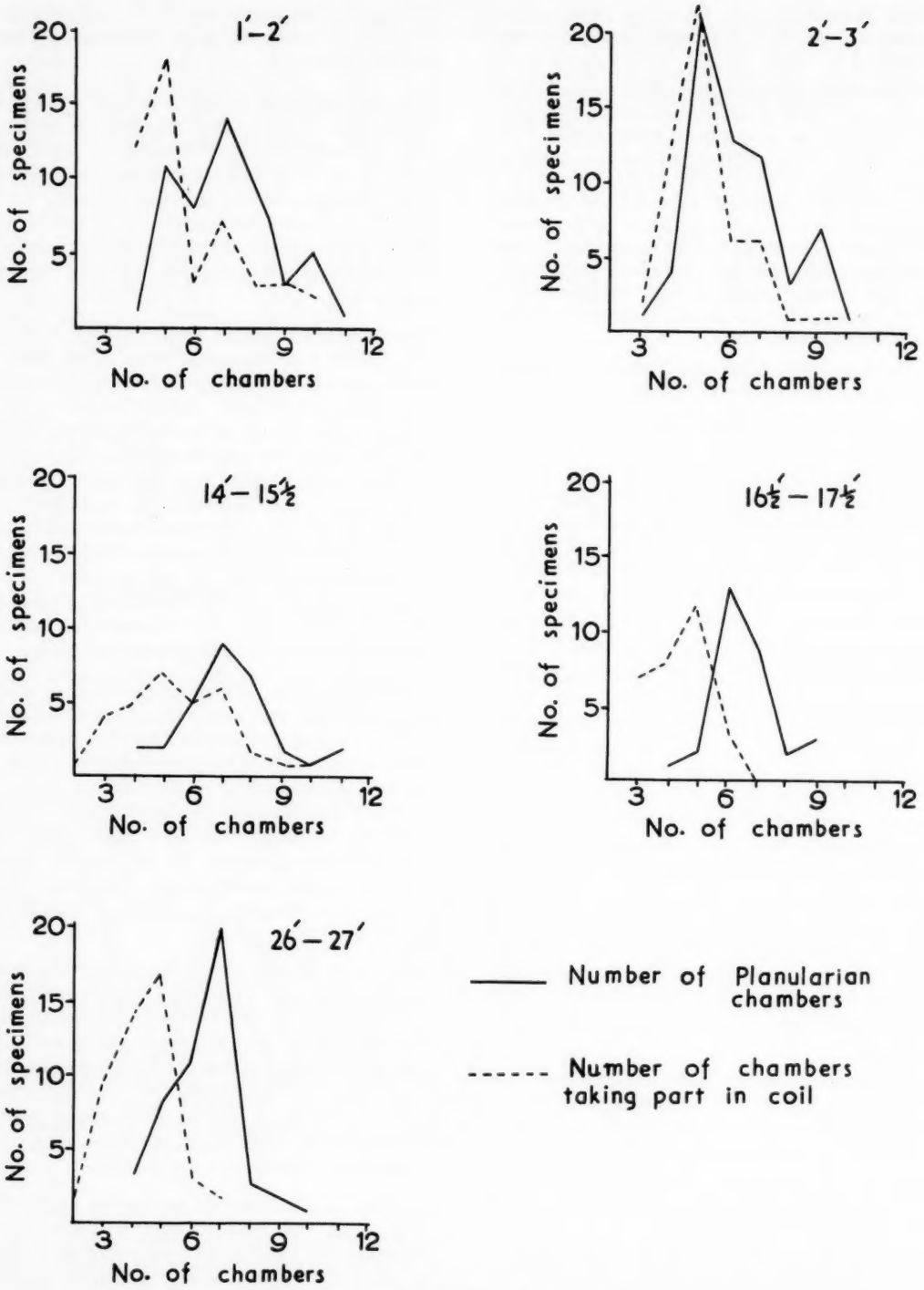
The usual series in coiling is present at 22–23 feet. Text-figure 3b shows the variation. Two main variants are present, nos. 1–3 being a larger, slightly more robust form, and nos. 6–9 an uncoiled elongate form, *Planularia dorsoarcuata* (Wiśniowski) or *Planularia filosa* (Terquem). Decrease in width and in coiling occurs simultaneously. The form *protracta* of Bornemann is less noticeable and not so well developed.

Two principal variants occur at 16½ to 17½ feet. The first is a short, broad form which has a very large proloculum and a relatively small number of chambers succeeding it, usually seven or eight. The coiling series can again be distinguished. Nearly all the specimens are megalospheric, the largest proloculum measuring 0.11 × 0.04 mm.; the shape of these forms varies from oval to subspherical. The second variant is a rather well-developed triangular form of *Planularia pseudocrepidula*. This variant forms an uncoiling series, at the end of which are a small number of specimens that resemble *Vaginulina* rather than *Planularia;* they are, however, no more than end members (all megalospheric) of the latter.

The first variant (text-fig. 3c, nos. 1–5) occurs in large numbers and is so strikingly different from the typical form of the species that it merits a distinct varietal name, *Planularia pseudocrepidula robusta*. Text-figure 4 shows graphs of the number of chambers possessed by *Planularia pseudocrepidula* and *Planularia pseudocrepidula robusta* Adams, n. var., at this horizon. The difference between the two can be seen even with this simple measurement. The genus *Planularia* attains its maximum abundance at the 16½ to 17½ foot level.

A return to a smaller size is evident at 14½ to 15½ feet (text-fig. 5b). The larger, more robust varieties are absent, their places being taken by small (usually less than 0.4 mm. in length), narrow individuals with highly oblique sutures. These could be referred to as *Planularia dorsoarcuata* (Wiśniowski), *Planularia filosa* (Terquem), and *Planularia anceps* (Terquem). Many may be young stages of *Falsopalmula*, of which comparable individuals are present.

At 10½ to 11½ feet, the specimens again attain a larger size, this time tending to become broadly triangular in outline. The variation in coiling and in width of test has already been referred to above and indicated in text-figure 1. Other variants present at this horizon are referable to *Planularia pro-*



TEXT-FIGURE 7

Falsopalmula; frequency polygons showing the number of planularian chambers and the number of chambers in a coil at five different levels.

tracta (Bornemann) and *Planularia filosa* (Terquem) (text-fig. 5c). There does not appear to be any way of distinguishing between them, and both are numerically of subsidiary importance to more typical examples of *Planularia pseudocrepidula*.

At 9 to 10 feet, variation is very similar to that at 10½ to 11½ feet. The triangular form of *Planularia pseudocrepidula* persists, and specimens referable to "*protracta*" and "*filosa*" are still present, although in reduced numbers. The absence of the long, narrow, uncoiled "*dorsoarcuata*" type is notable.

From this point on, *Planularia* is gradually replaced in importance and numbers by *Falsopalmula*, and it is impossible to separate the young stages of the two genera. All the specimens of *Planularia* tend to be small, although they continue to exhibit various stages of coiling and uncoiling. Text-figure 6 shows some of this variation. Many specimens similar to these have, in the past, received specific names, but it is evident that they are merely young stages of *Planularia* and *Falsopalmula*. Specimens similar to those figured have been recorded as *Cristellaria gracilis* Kübler and Zwingli, *Cristellaria argovensis* Kübler and Zwingli, *Cristellaria parkinsoni* Kübler and Zwingli, *Cristellaria mitra* Kübler and Zwingli, and *Cristellaria semi-involutina* Terquem var. *plana* Deecke. It is significant that all these "species" were recorded as rare by the original authors, and it is to be noted that they are all megalospheric.

Conclusions: In this succession, the genus *Planularia* is represented by *Planularia pseudocrepidula* Adams, n. sp., a species that exhibits considerable morphologic variation. Of common occurrence at certain horizons are specimens referable to *Planularia protracta* (Bornemann), *Planularia dorsoarcuata* (Wiśniowski), etc. Isolated specimens appear to be quite distinct forms, but when large numbers are examined they are not clearly separable from *Planularia pseudocrepidula*. It is not intended to suggest that such forms can never be present without grading (this may occur in some areas), but only that in the present case they cannot be satisfactorily distinguished. There occur, as end members of a series graded in coiling, a number of specimens similar to those which Franke (1936) designated as *Vaginulina* (*Vaginulina anceps* Terquem). Such specimens do not, in fact, belong to the genus *Vaginulina* d'Orbigny, but to *Planularia* Defrance; they differ from typical members of the latter genus only in being less coiled. The reason for the confused nomenclature associated with these species appears to be that the early workers, knowing little or nothing about reproductive dimorphism, gave a new specific name to every specimen that differed in shape from its fellows. Yet this difference in appearance is largely a feature of the megalospheric generation, and most of the variants that occur, although common at a given level, are impersistent in time. The fact that similar forms, e.g., *Planularia dorsoarcuata* (Wisniowski) appeared several times in the Jurassic does not necessarily imply any direct genetic continuity between them. On the contrary, it is far more likely that such morphologic "species" are homeomorphs of one another.

The author therefore suggests that, when dealing with communities of Jurassic members of the genus *Planularia*, different names should not be allotted to what at first sight seem to be radically different species unless (a) enough individuals have been examined to show that there is no gradation between them, and (b) microspheric forms matching each type of megalospheric form can be found. In the present investigation the strikingly different megalospheric forms could not be matched by different microspheric forms, and the former graded into one another. Specific differences based on the amount of coiling of the megalospheric form are seen to have no validity in the present case, as all gradations between coiled and uncoiled forms exist.

Planularia pseudocrepidula Adams var. **robusta** Adams, **new variety**
Text-figures 2–4

Diagnosis: Test short and broad, composed of from six to eleven chambers, usually about seven. In the megalospheric form the proloculum is large, generally oval in shape, and is usually followed by chambers which increase rapidly in width, the first few tending to form part of the initial coil.

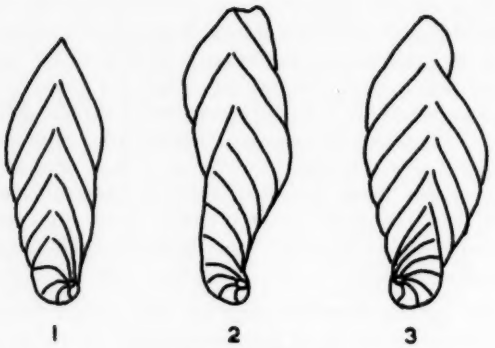
Dimensions: Maximum length 0.64 mm.; maximum width 0.25 mm.

Variation: The tests vary greatly in shape, but the apertural edge is usually fairly strongly arcuate, especially in the early stages. The number of chambers making up the coil varies from two to seven, with three to five being the usual number.

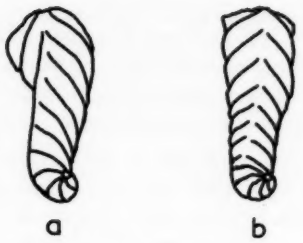
Remarks: This variety differs from typical members of the species in the larger size and smaller number of the chambers. No definite microspheric forms were observed, but the specimens with the smallest prolocula always possess a fairly tight initial coil. This form was found at only one level.

Types: Holotype, B.M.N.H. no. P.43376. Paratypes, B.M.N.H. no. P.43377.

Material: Ninety-one specimens from the Upper Lias of northern Lincolnshire, at 16½ to 17½ feet from the top of the section.

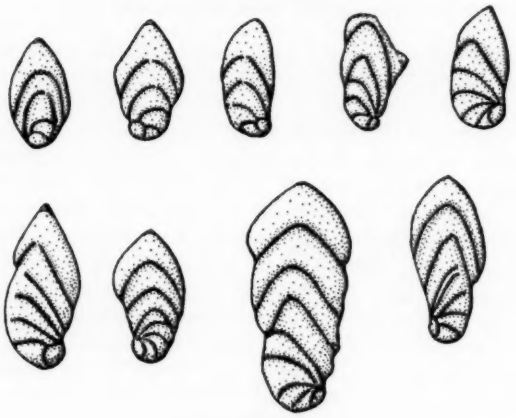


TEXT-FIGURE 8

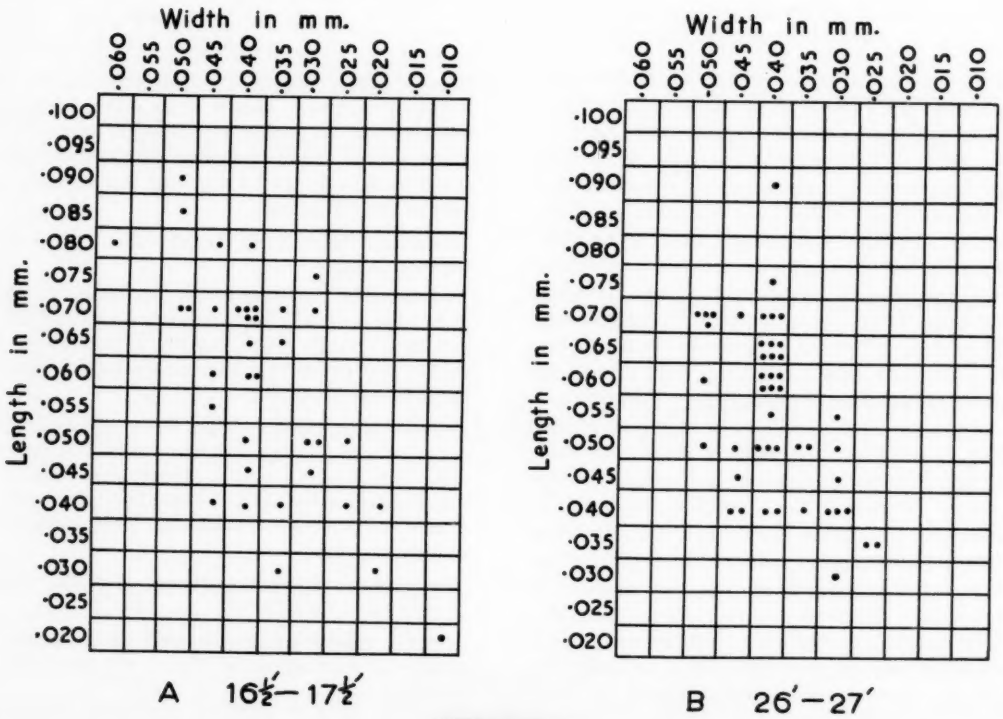


TEXT-FIGURE 9

TEXT-FIGURE 10



TEXT-FIGURE 11



TEXT-FIGURE 12

Genus **Falsopalmula** Bartenstein, 1948
Text-figures 7–12

This recently erected genus comprises many Jurassic species previously classed as *Flabellina*, a generic name which Bartenstein (1948*b*) replaced by *Neoflabellina* on the ground that the former name was preoccupied by that of a mollusk. In the same year, Bartenstein (1948*a*) further stated that *Neoflabellina* was not known to occur before the Cretaceous. *Falsopalmula* also includes species previously assigned by many American workers to the genus *Palmula* Lea. The latter name had often been used as a synonym of *Flabellina*, but Bartenstein (1948*b*) established it as a valid genus, the earliest recorded appearance of which is in the upper part of the Lower Cretaceous.

Falsopalmula appeared first in the Lower Lias, although not immediately in great numbers. In Upper Lias time, however, it became abundant and was of universal distribution. One of the most striking features of the genus is the wide variety of form displayed by the individuals included in certain of its species, and there can be little doubt that this wide degree of individual variation has led to the multitude of specific names that have been erected.

Falsopalmula is present in almost all of the samples from northern Lincolnshire, being least numerous in the lowest 25 feet, where the majority of other genera are most strongly represented, and most abundant in the upper part, where many others are lacking. In this respect it parallels almost exactly the distribution of *Planularia*.

The typical form: A typical Lias example of *Falsopalmula* is a small, free-living, calcareous perforate form consisting of an initial coiled series of planularian chambers followed by a number of chevron-shaped chambers. The aperture is terminal and situated at the peripheral edge of the last chamber in the young stage, and at the angle of the chevroned chambers in the adult. It appears to be radiate. Recognition of the generic characters is, therefore, a relatively simple matter, but this is often not the case with characters of specific significance. Bearing in mind the difficulties experienced by previous workers, an attempt has been made to assess the value of the features hitherto deemed to be of specific importance, when these are applied to the present material. To this end, some 400 specimens have been examined.

The following characters have, from time to time, been considered as being of diagnostic value in the identification of species of *Falsopalmula* (*Flabellina* of older authors): Number of "cristellarian" (planularian) chambers; number of chevron-shaped chambers; amount of overlap of the chevrons onto the earlier chambers; degree of initial coiling; angle made by later sutures of the planularian part and the peripheral wall; presence of ribs or striations; shape of individual chambers; shape and size of proloculum; amount of lateral compression of the test; and depth of sutures.

The number of planularian chambers: The minimum number recorded was three (including the proloculum). Only one such specimen was found, the usual minimum at any level being four. Individuals of this type are few in number and invariably represent the megalospheric generation. The maximum number recorded was twelve, and again only one such individual was found, the usual maximum being ten or eleven according to the horizon; these forms are always microspheric. At every level where *Falsopalmula* was found, there was always a difference of six to eight chambers between the one with the least and the one with the greatest number. Text-figure 7 shows several graphs which indicate the number of "planularian" chambers possessed by specimens at different levels. Only one species is represented. (Superimposed on these diagrams are graphs showing the number of chambers taking part in the initial coil.) The main peak varies from the five- to the seven-chambered stage at different horizons, and the microspheric forms may show a small peak at nine or more. Despite the relatively wide variation in number of planularian chambers (three to nine in the megalospheric generation), there is clearly no indication that more than one species is present.

TEXT-FIGURES 8–12

8, *Falsopalmula*, showing variation in the amount of overlap of the first equitant chamber on the dorsal wall of the test, from sample at 49–50 feet. 9, *Falsopalmula*, two specimens illustrating different methods of formation of the equitant chambers; gradations occur between the two. 10, *Falsopalmula* cf. *deslongchampsi* (Terquem), showing variation in coiling amongst megalospheric forms, all × ca. 39. 11, *Falsopalmula* cf. *deslongchampsi* (Terquem), drawings showing some of the variation that occurs amongst small individuals toward the top of the section; shape of proloculum and of early chambers, and mode of formation and degree of overlap of chevron chambers are particularly variable. 12, *Falsopalmula* cf. *deslongchampsi* (Terquem), showing variation in the size of the proloculum at two levels; each point represents one specimen; the rarity of microspheric individuals is notable.

Number of chevron-shaped chambers: This varies between one and seven in the present material. Brief consideration reveals that this is an unsatisfactory distinguishing feature because it obviously reflects the growth stages of the individuals. As it is difficult to know whether a particular specimen is fully developed or not, and as changes in the environment may possibly limit growth, the matter becomes complex. However, counting the number of equitant chambers and plotting them against the number of planularian chambers developed produced a normal scatter-diagram which gave no indication (by separate concentrations of points) that more than one species was present.

Amount of overlap of chevrons: The equitant chambers may overlap the earlier chambers either on the apertural or on the non-apertural side of the test, and sometimes on the two together. In the present instance, overlap onto more than one "planularian" chamber is common only on the apertural side. Inspection of a group of forms from any level generally reveals that the amount of overlap is highly variable, as shown in text-figure 8. Here the first equitant chamber overlaps from one to three planularian chambers. At one horizon, overlap over four planularian chambers was seen.

The equitant chambers may form in two ways. The most common method involves a sudden change in growth pattern with resultant overlap of one arm of the chevron down the apertural side of the test (text-fig. 9a). The second type is formed by the gradual inward curvature of the apertural wall so that there is no abrupt alteration in the mode of growth (text-fig. 9b). A specimen of the latter was figured by Terquem (1864, pl. 10, fig. 13) as *Flabellina deslongchampsi* Terquem.

The time of onset of growth of the chevron chambers is, as stated earlier, highly variable. It may occur after three ordinary chambers or after as many as twelve. It may follow a tightly coiled or completely uncoiled initial part, or it may appear after any intermediate stage between the two.

Degree of initial coiling: In the structure of its initial coil, *Falsopalmula* does not differ from *Planularia*, and the remarks made under that genus apply equally to the present one.

Text-figure 10 indicates the variation in coiling that exists at one level, and the number of specimens with the same amount of coiling at that level can be seen in text-figure 7. The degree of coiling has been used many times as a means of delimiting species, and it thus happens that in the series referred to above (text-fig. 10) at least two "species" can be recognized. Specimen 3 could be assigned to *Falsopalmula deslongchampsi* (Terquem), and specimen 6 to *Falsopalmula semicristellaria* (Schwager).

Completely uncoiled specimens, such as number 6 in text-figure 10, are fairly common in the Upper Lias, occurring as end members of a gradational series in coiling. Cretaceous and later specimens exhibiting a similar morphology, i.e., an initial "vaginuline" stage followed by equitant chambers, are placed in a separate genus, *Flabellinella* Schubert. Individuals resembling *Flabellinella* in the Upper Lias are certainly not generically distinct, although they may represent the beginning of a new stock. Macfadyen (1941, p. 58) notes in his description of *Flabellina centro-gyrata* Terquem that "*Flabellina*" *semi-cristellaria* Schwager, found in the Dogger, differs from the former only in its degree of coiling. He did not, therefore, include it in his synonymy, but accepted the difference as being of specific importance. Similar considerations have affected other authors; Loeblich and Tappan (1950, p. 58) state, regarding *Falsopalmula antrorsa*, that it "... differs from *Flabellina centralis* Terquem in having a tighter coil. It is about one-third smaller than *Flabellina centro-gyrata* Terquem, has more oblique sutures and a less well-developed coil. *Flabellina obliqua* Terquem is somewhat similar, but has a more enrolled early stage...." These authors lay emphasis on the condition of the coil, but they do not say how many specimens were found or how much variation existed amongst them. The description and figure given would fit a number of the specimens from Risby-Warren. It is therefore evident that the amount of coiling shown by an individual, if considered alone, may be of no value in determining its species.

The suture angle: The angle at which the dividing sutures cross the test has sometimes been thought to be of diagnostic value (e.g., Macfadyen, 1941) in differentiating between *Falsopalmula obliqua* and *Falsopalmula centro-gyrata*. Examination of numerous specimens has convinced the author that in the present case it is a feature of little value. In other regions, where individual variation is less pronounced, as Barnard (1950*a*, p. 350) states is the case in the Lower Lias of the Dorset area, then the obliquity of the sutures may be a feature of more significance. It was unfortunately not found possible to analyse this variation quantitatively because of the difficulty involved in measuring the angles accurately in small specimens and also because the shape of individual chambers is variable.

Ornament: Ornamented examples of *Falsopalmula* are not known to occur in the Upper Lias of England. Such species as *Falsopalmula tenuistriata* (Franke) and "*Flabellina insignis*" Terquem and Berthelin appear to be characteristic of the continental Lias but to be lacking in Britain. It is interesting to note that striate specimens of *Planularia* are also virtually absent.

Shape of the chambers: The shape of individual chambers often varies considerably within a single specimen and cannot be considered of much significance. Modification during growth, due to a response to an external stimulus, may be responsible for many individual peculiarities. Particularly noticeable is the tendency for a small chamber to be inserted occasionally between larger ones. The chambers of megalospheric forms appear to be more variable in shape than those of microspheric forms, but few of the latter are ever available for examination. Text-figure 11 shows some of the variation that occurs at one level high in the succession.

Shape and size of proloculum: In the past it has been the practice of authors to state the shape of the proloculum when describing a new species; terms such as oval, elongate, globular, elliptical, egg-shaped, etc., are in common use. However, except in the case of a spherical proloculum, the shape appears to vary according to the angle from which it is observed, and this is usually determined by the arrangement of the following chambers. Examination has shown that, although a great variety of shapes are present, most individuals have spherical or oval prolocula with various modifications usually caused by a flattening of part of the wall (see text-fig. 11).

In the present case, proloculum size was found to be of more significance than shape, though here again a continuous gradation can usually be found between the smallest and the largest in any group. Generally the diameter varies from 0.01 to 0.10 mm. Text-figure 12 shows the variation in proloculum size at two levels. The absence of the microspheric form is evident in the second diagram.

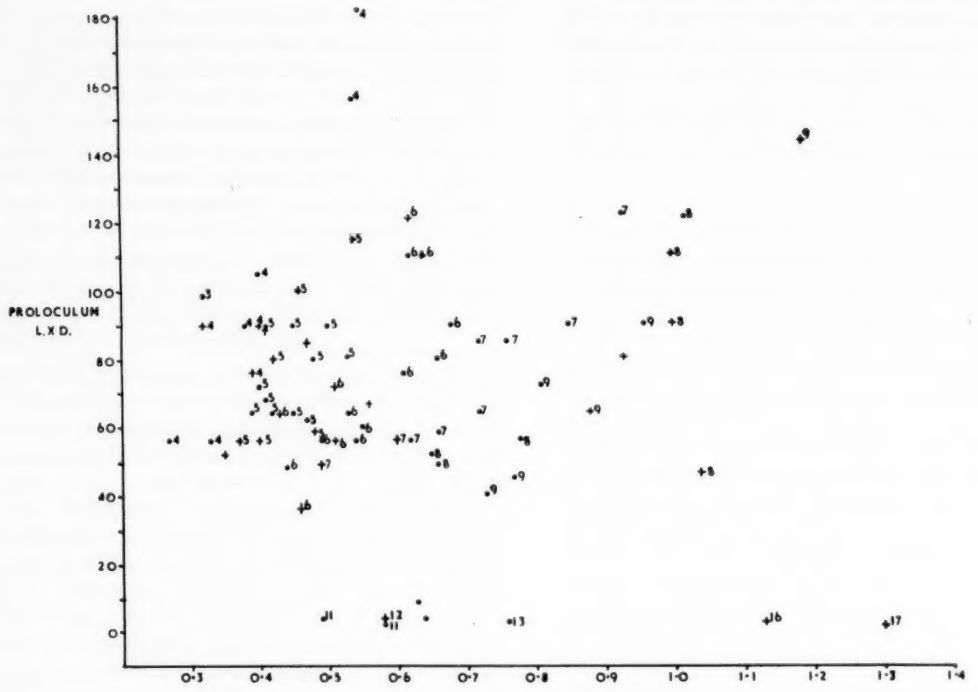
A relationship between the size of the proloculum and the degree of coiling is evident after inspection of a few specimens. All of the microspheric forms are tightly coiled (eight or more chambers taking part in the coil), whilst the megalospheric forms vary greatly in their degree of enrolling. A feature of these assemblages is the great rarity of microspheric individuals.

Lateral compression of the test: This character raises fundamental questions concerning the status of the genera *Falsopalmula* and *Planularia*. Regarding the former, this investigation yielded a few forms, the initial coiled part of which is arched in cross-section and lenticuline in appearance. These were assigned to the genus *Lenticulina*, as they were evidently variants of one of its species. Barnard (1950*b*) noted a similar phenomenon among specimens from the Upper Lias of Byfield.

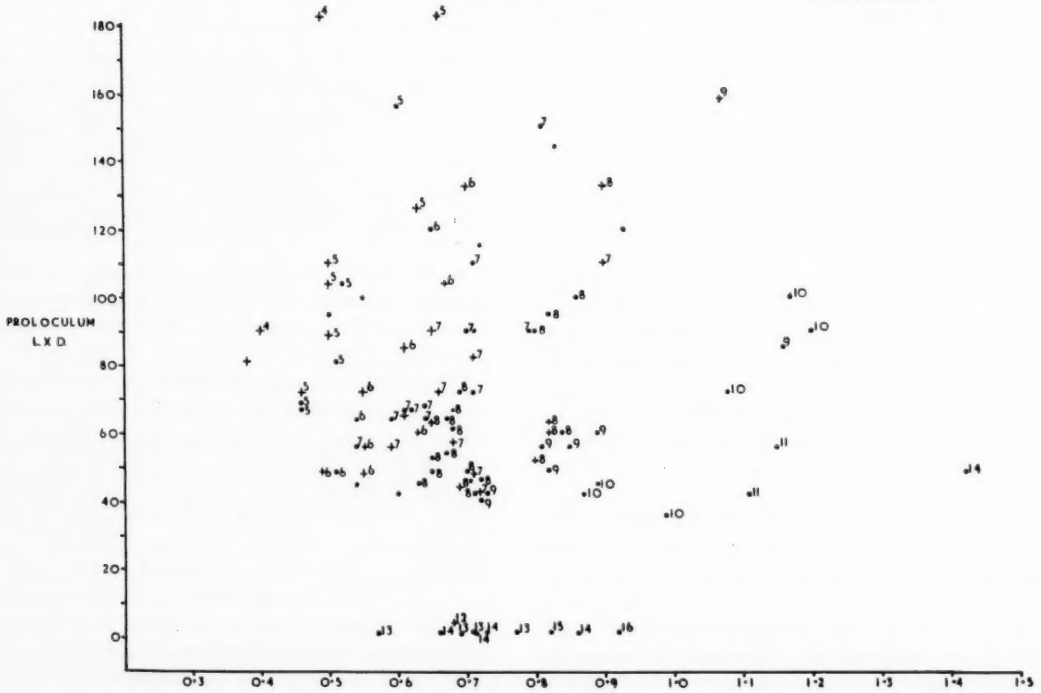
In the case of *Planularia*, increase in the arching of the walls leads to the production of forms which can be referred only to the genus *Astacolus*. Such specimens have been found. Brotzen (1953, p. 36) states that "...all lagenid genera, as early as the Triassic and Jurassic, were divided into a number of very different groups, which had very constant characters at that time. One of these constant characters is the shape of the cross-section, which may be rounded, oval, triangular or rectangular." To the present author this statement is unacceptable. Taking but a single instance, that of *Planularia* and *Astacolus*, it is evident that if the cross-section of the former always revealed parallel sides, and that of the latter biconvex sides, no difficulty would be experienced in distinguishing between them. In point of fact, as Bartenstein pointed out (1948*c*, p. 52), transitions between the two do occur, and they are often difficult to separate.

Depth of the sutures: This feature is probably not of very much significance. Slight variation does occur between individuals, and Franke (1936) used the difference in depth of the sutures to distinguish between *Flabellina deslongchampsi* Terquem and *Flabellina jurensis* Franke. Later workers have not accepted these differences as being of diagnostic importance. There is a general tendency amongst many lagenid genera and species, including *Falsopalmula*, for the sutures over the later part of the test to become slightly deepened relative to the earlier sutures.

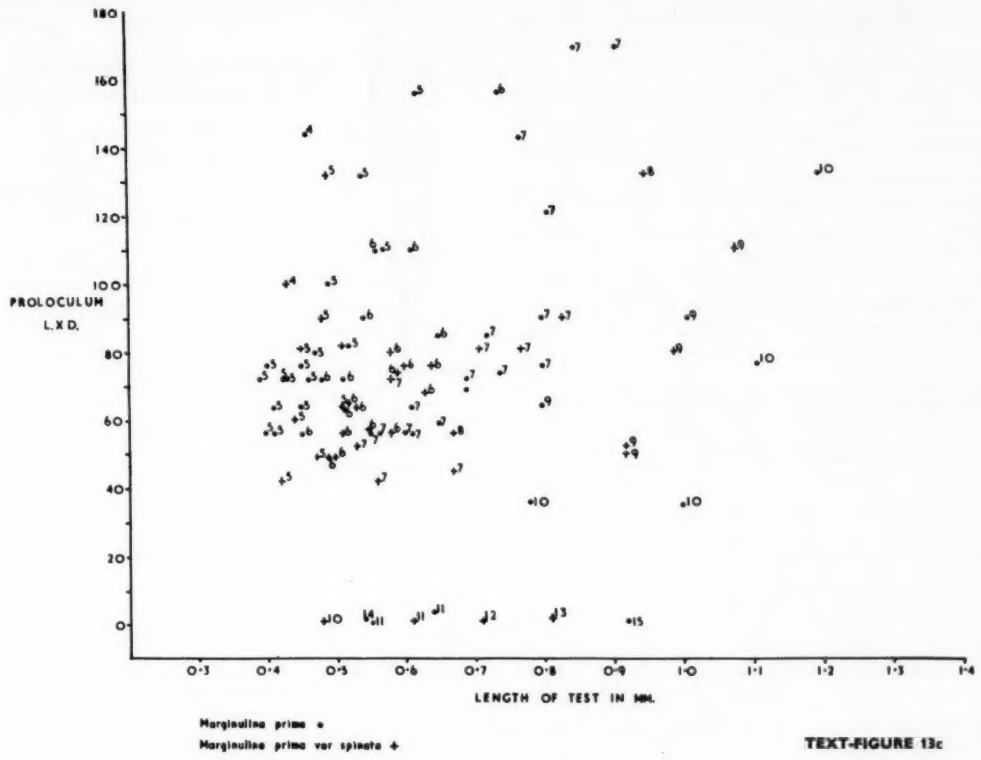
Remarks: The foregoing observations have been made on a very variable suite of specimens which, despite their variation, appear to belong to a single species of the genus *Falsopalmula*. A very constant and remarkable feature of the genus is its association with *Planularia*. This has been noted previously by Bartenstein (1948*b*), who observed the similarity between *Planularia cordiformis* (Terquem) and the initial part of *Falsopalmula deslongchampsi* (Terquem), and between *Planularia crepidula* (Fichtel and Moll) and *Falsopalmula obliqua* (Terquem). He deduced that in each case the species of *Falsopalmula* was derived from the corresponding species of *Planularia*. In



TEXT-FIGURE 13a



TEXT-FIGURE 13b

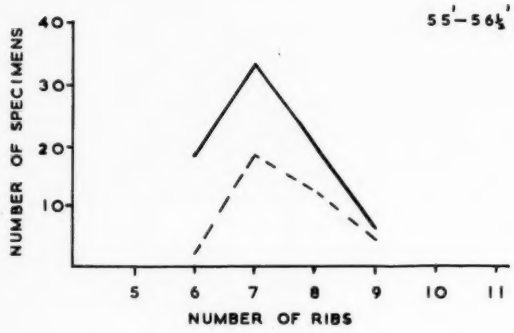


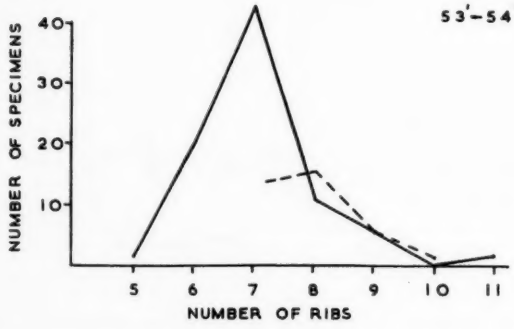
TEXT-FIGURE 13

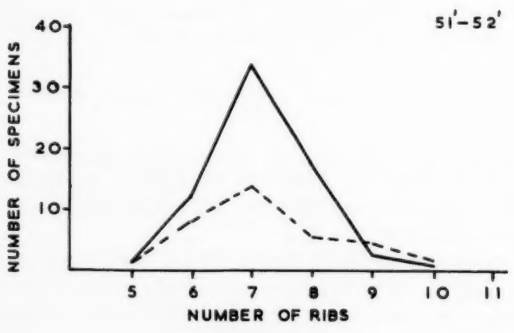
Marginulina prima d'Orbigny, distribution diagrams showing dimorphism. The length of the test is plotted against the horizontal scale, the product of the length × breadth of the proloculum (× 1000) against the vertical scale. The number beside each point indicates the number of chambers in the test. Microspheric and megalospheric forms are clearly separated, the latter being highly variable: a, at 51–52 feet; b, at 53–54 feet; c, at 55–56½ feet.

northern Lincolnshire, *Falsopalmula* is associated with *Planularia pseudocrepidula* Adams, n. sp., a species already stated to be very variable, and it is interesting to see that the variation in coiling seen in *Planularia pseudocrepidula* can be exactly matched by that of *Falsopalmula*. It would seem from this that the specimens of *Falsopalmula* from the Upper Lias of northern Lincolnshire should be referred to the species *Falsopalmula obliqua* (Terquem), yet they do not exactly match those described under this name by Bartenstein. Actually, they more closely resemble Terquem's original figure of *Falsopalmula deslongchampsi*, and their range of variation is very great. These differences, however, may perhaps be accounted for by minor differences in the environment affecting the growth of the tests. (It should be noted that Terquem's original figure of *Flabellina deslongchampsi* does not show an initial stage resembling a typical *Planularia cordiformis* (Terquem) as Bartenstein indicates, so that the nomenclature remains very involved.)

Conclusions: No single character has been discovered which, in itself, is sufficiently stable to be of great value in delimiting species. The same general remarks concerning the futility of erecting species on too few specimens apply here as in the case of *Planularia* discussed earlier. The variation seen in *Falsopalmula* parallels that of *Planularia* so closely as to suggest that, bearing in mind Bartenstein's earlier evidence, almost any species of *Planularia*, at least in the Upper Lias, may produce equitant chambers and thus become a *Falsopalmula*. The similarity in coiling between the two genera is very significant in this connexion.

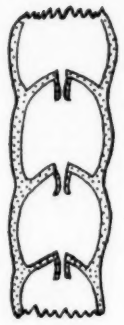




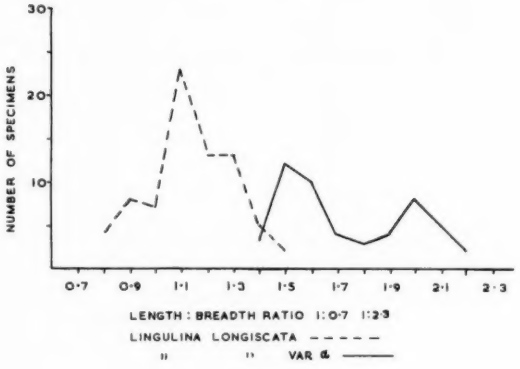


TEXT-FIGURE 14

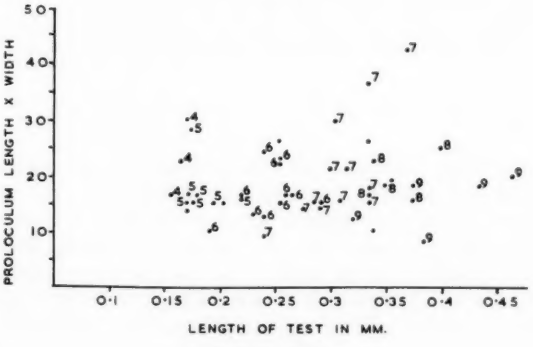
TEXT-FIGURE 15a



TEXT-FIGURE 15b



TEXT-FIGURE 16



TEXT-FIGURE 17

TEXT-FIGURES 14–17

14, *Marginulina prima* d'Orbigny, frequency polygons showing variation in number of ribs at three different levels. 15, *Lingulina longiscata* (Terquem): a, external appearance, × 70; b, interior of chambers showing siphons viewed by transmitted light after oil immersion. 16, graphs showing the difference in length: breadth ratio of *Lingulina longiscata* (Terquem) and *Lingulina longiscata* (Terquem) var. *alpha* Adams, n. var.; these graphs include the full number of specimens from all levels. 17, *Lingulina tenera* Bornemann, distribution diagram showing variation in the megalospheric form at 51–52 feet; the number beside each point indicates the number of chambers in the test; the absence of a number indicates that the test was broken and the number of chambers uncertain; no microspheric forms appear to be present.

Genus MARGINULINA d'Orbigny, emend. Marie, 1941

Marginulina prima d'Orbigny
Text-figures 13–14, 18–20

Marginulina prima D'ORBIGNY, 1850, Prodrome Pal., vol. 1, p. 242, no. 262. – MACFADYEN, 1936, Roy. Micr. Soc. London, Jour., ser. 3, vol. 56, p. 151, pl. 1, fig. 262a. – FRANKE, 1936, Preuss. Geol. Landesanst., Abh., new ser., no. 169, pl. 8, figs. 1–7 (including the forms *rugosa* Bornemann, *gibbosa*, *recta*, *acuta*, and *ornata* Terquem, and *praelonga* and *gibberula* Terquem and Berthelin). – BARTENSTEIN AND BRAND, 1937, Senckenb. Naturf. Ges., Abh., no. 439, p. 161, pl. 2B, fig. 26; pl. 3, figs. 39–40; pl. 4, fig. 60a–b; pl. 5, fig. 46a–b. – MACFADYEN, 1941, Roy. Soc. London, Philos. Trans., ser. B, vol. 231, no. 576, p. 38, pl. 2, fig. 32a–b. – BARNARD, 1950, Geol. Soc. London, Quart. Jour., vol. 105, pt. 3, p. 372, text-fig. 5a–b, g.

Marginulina raphanus (Linné). – BRADY, 1867, Somersetshire Archaeol. Nat. Hist. Soc., Proc., vol. 13, pt. 2, p. 225, pl. 2, fig. 21. – CRICK AND SHERBORN, 1891, Northamptonshire Nat. Hist. Soc., Jour., vol. 6, p. 211, pl. 1, fig. 18.

Marginulina burgundiae Terquem. – ISSLER, 1908, Palaeontographica, vol. 55, p. 67, pl. 4, figs. 171–174. – FRANKE, 1936, Preuss. Geol. Landesanst., Abh., new ser., no. 169, p. 78, pl. 8, fig. 8.

Marginulina incisa FRANKE, 1936, ibid., p. 78, pl. 8, figs. 11–12.

Description: The megalospheric test consists of a rectilinear series of chambers up to fourteen in number. Individuals possessing six to nine chambers are the most common. The proloculum is subspherical, generally apiculate, and is followed by chambers which increase fairly regularly in size, the rate of increase depending on the size of the proloculum. Specimens with large prolocula tend to increase but little in width with age, many remaining almost parallel-sided. The chamber walls are often very thick; the septa are usually transverse, but in some cases slope obliquely toward the non-apertural side. In such forms the test is often slightly arcuate, the apertural side being convex. The aperture is terminal, radiate, raised on a short neck and offset to one side of the test. If the extreme tip of the aperture is missing, the inside of the neck is seen to be circular.

Ornamentation consists of a number of strong ribs which traverse the test longitudinally. These cross the sutures without interruption and continue down to the proloculum. The ribs vary from five to ten in number, but usually there are about seven, fresh ones being added as the test increases in circumference. Each rib may remain independent over its whole length or may fuse with its neighbours on the upper surface of the last chamber. In most cases the sutures are flush, but in some adult specimens there is a tendency for the chamber junctions to become incised, thus causing the later chambers to appear more globular.

The microspheric form consists, when fully grown, of from eleven to sixteen chambers. Usually there are about thirteen or fourteen. A minute proloculum (approximate diameter 0.01 × 0.01 mm.) is followed by an initial coil in which four or five chambers take part. The test then increases rapidly in size, the adult stage being similar to that of the megalospheric form.

The microspheric and megalospheric individuals are quite distinct, no specimens with prolocula of intermediate size having been discovered. Text-figure 13a–c shows quite clearly the separation of the two forms.

Variation: This species exhibits considerable variation both vertically through the succession and among specimens obtained from a single sample. The distribution diagrams (text-fig. 13a–c) indicate the range of variation which occurs and also show that it is the megalospheric form which is responsible for the greater part. In spite of the range of size shown by the megalosphere, there is no indication of trimorphism.

At 53–54 feet there is a tendency for very elongate forms to develop; these are fairly robust but slender. At 51–52 feet a shorter, broader form is more in evidence. This particular variant increases rather rapidly in width and appears conical when viewed from the side. At higher horizons, individuals are reduced in number, probably owing to an environmental control. At 51 feet there is a change in lithology, grey micaceous shale giving way to a slightly harder non-micaceous shale, whereupon the number of individuals is immediately reduced.

A certain amount of variation occurs in the number of ribs present on each specimen. In general, the number is dependent on two factors:

a) The age of the specimen, i. e., the number of chambers it has formed. Later chambers tend to be larger and to possess more ribs.

b) The size of the proloculum. Megalospheric forms generally possess more ribs than microspheric forms because at a given chamber the megalospheric individual is usually the larger. Text-figure 14 shows the variation in the number of ribs per specimen at three levels where material was abundant.

Remarks: The large number of names under which this species has been recorded reflects the wide range of variation which it shows. Franke (1936) recognised seven forms of *Marginulina prima* (*Marginulina prima* formae *rugosa*, *gibbosa*, *praelonga*, *recta*, *acuta*, *gibberula*, and *ornata*), these names having been used earlier as specific names. The enumeration of such forms appears to be quite pointless, especially in the present instance, when all occur together within a very few feet of strata. Franke apparently applied different "form" names to megalospheric and microspheric individuals. Macfadyen (1941) included many previously recognised "species" under the name *Marginulina prima*.

This is believed to be the first record of the species from the Upper Lias of England. Bartenstein and Brand did not record it from any strata higher than Lias δ in Germany (= *spinatum* zone in Britain).

Types: Hypotypes, B.M.N.H. no. P.43378.

Material: Approximately 200 specimens from the Upper Lias of northern Lincolnshire.

Marginulina prima d'Orbigny var. **spinata** Terquem
Text-figure 21

Marginulina spinata TERQUEM, 1858, Acad. Imp. Metz, Mém., vol. 39, p. 615 (55), pl. 3, fig. 8. – MACFADYEN, 1941, Roy. Soc. London, Philos. Trans., ser. B, vol. 231, no. 576, p. 39, pl. 2, fig. 33a–b.

Marginulina interrupta Terquem forma *spinata* Terquem. – FRANKE, 1936, Preuss. Geol. Landesanst., Abh., new ser., no. 169, p. 79, pl. 8, fig. 10.

Marginulina spinata spinata Terquem. – BARTENSTEIN AND BRAND, 1937, Senckenb. Naturf. Ges., Abh., no. 439, p. 161, pl. 4, fig. 61; pl. 5, fig. 47.

Description: The test is similar in general appearance to that of *Marginulina prima*, but differs from the latter in that the ribs are interrupted at the sutures and tend to project downward as little spines. In some specimens it is only the lower part of the test which develops this spinate type of ribbing, whereas in the upper portion the ribs are complete.

Remarks: It has previously been the custom of all authors to separate *Marginulina spinata* from *Marginulina prima* as a distinct species, the difference in the character of the ornament having been considered a diagnostic feature. Careful examination of the present material has led the author to conclude that such a separation is not warranted on this occasion. Apart from the ornament, there are no features by which the "species" may be distinguished. Measurements of the size of the proloculum and length of test, when plotted together with the number of chambers (see text-fig. 13a–c), do not reveal any differences, nor is the total number of ribs any different (text-fig. 14). Many individuals are found in which only the lower part of the test bears incised, spinous ribs, and in others the ribs are not completely incised but are saw-shaped. Franke (1936) described the ribs of *Marginulina interrupta* forma *spinata* as saw-shaped, the rib section increasing in height from the upper to the lower suture. Macfadyen (1941), in describing the species *Marginulina spinata*, had only two specimens to which to refer. These possessed fifteen and thirteen medium to small costae, respectively. The number of ribs possessed by the present specimens never exceeds ten, and more usually is seven or eight. In his original description, Terquem stated that seven weak ribs were present.

In view of the extreme difficulty experienced in distinguishing between many of the specimens, especially when they are found with the outer edges of the ribs broken, and because both types have the same range, it is not considered that the spinate forms merit more than varietal status. The proportion of *Marginulina prima* to *Marginulina prima* var. *spinata* was found to vary between different levels, but as they are greatly reduced in numbers above 50 feet, little signifance can be attached to this fact.

It has been noted that there is a tendency for specimens to have discontinuous ribs whenever the chamber junctions become moderately or strongly incised. This does not invariably occur, but, on the other hand, no specimens having the sutures flush with the surface have been observed to possess interrupted ribs.

Types: Hypotypes, B.M.N.H. no. P.43379.

Material: One hundred sixty specimens from the Upper Lias of northern Lincolnshire.

Genus **Lingulina** d'Orbigny, 1826

Lingulina is widespread throughout the Upper Lias of Lincolnshire, and at least seven described species have been recognized during the present investigation. Confusion has always existed concerning the diagnosis of the genus, the trouble arising from a very poor original description by d'Orbigny (1826). A full discussion of the nomenclatural problem is in the course of preparation, and it is sufficient to state here that the author has included in the genus *Lingulina* all lagenids possessing a rectilinear series of chambers, often strongly compressed laterally, which have the septa arranged at right angles to the long axis of the test or which are only weakly chevron-shaped, and in which the aperture is central, terminal, elongate, slit-like or oval. Although all the characters must be considered when determining the genus, the slit-like nature of the aperture seems to be the most important. Of the species investigated, *Lingulina longiscata* (Terquem) proved to be one of the most interesting.

Lingulina longiscata (Terquem)
Text-figures 15–16, 23–24

Lingulina carinata d'Orbigny. – JONES AND PARKER, 1860 (part), Geol. Soc. London, Quart. Jour., vol. 16, p. 453, pl. 19, fig. 15 only.

Frondicularia striatula Reuss. – JONES AND PARKER, 1860, ibid., p. 453, pl. 19, figs. 17–18.

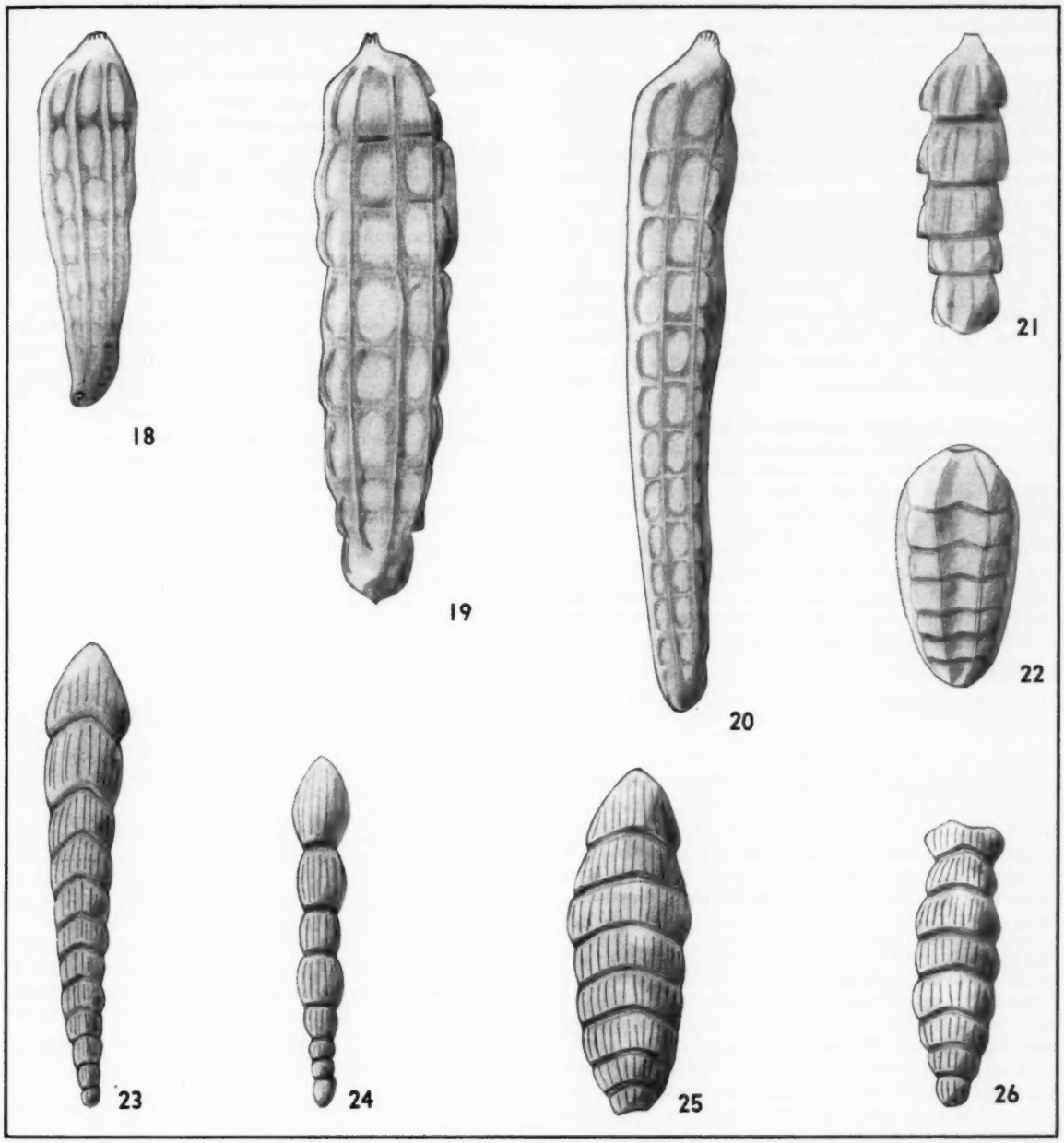
Frondicularia longiscata TERQUEM, 1870, Acad. Imp. Metz, Mém., vol. 51, p. 318, pl. 22, figs. 23–24.

Frondicularia nodosaria TERQUEM, 1870 (part), ibid., p. 319, pl. 22, fig. 25 only.

Frondicularia lanceolata (Häusler). – ISSLER, 1908 (part), Palaeontographica, vol. 55, p. 54, pl. 2, fig. 103 only.

?Frondicularia mesoliassica Brand. – BARTENSTEIN AND BRAND, 1937 (part), Senckenb. Naturf. Ges., Abh., no. 439, p. 158, pl. 4, fig. 66 (not p. 159, text-fig. 16).

Description: A very fragile test formed of up to twelve chambers in a rectilinear series. Although laterally strongly compressed, in cross-section the sides are rounded. Growth, whilst fairly regular in some specimens, is sometimes irregular, alternately large and small chambers tending to develop. The later chambers often tend to decrease slightly in width, giving the test a lanceolate appearance. The proloculum is either elongate or subspherical, and its junction with the second chamber is perfectly straight. The aperture is central, terminal, oval or slit-like, and flush with the surface. Usually it is very difficult to see. In rare cases, when the end chamber is particularly pointed in outline,



TEXT-FIGURES 18–26

18–20, *Marginulina prima* d'Orbigny, × ca. 76: 18, microspheric form; 19–20, megalospheric forms. 21, *Marginulina prima* d'Orbigny var. *spinata* Terquem, × ca. 76. 22, *Lingulina tenera* Bornemann, × ca. 105. 23–24, *Lingulina longiscata* (Terquem), × ca. 105. 25–26, *Lingulina longiscata* (Terquem) var. *alpha* Adams, n. var., × ca. 105: 25, an exceptionally broad individual.

the aperture approaches a round condition. The sutures are chevron-shaped, except in the early stages of some specimens, where they are straight.

When mounted in a clarifier and viewed with transmitted light, a short "siphon" can be seen projecting down into the lumen of each chamber from the apertural margin (text-fig. 15). In longitudinal sections, this structure resembles a tiny funnel with its walls concave inward. The aperture itself is often blocked by a calcite plug. The author knows of no other record of this small structural feature in Liassic species of *Lingulina*, but this may be due to other workers having examined the tests in the dry condition. Buchner (1942) has described somewhat similar structures in living representatives of the genus. He calls the downward projections "siphons," and in his figured specimens they are often very long and quite straight.

The test is ornamented externally by numerous very fine striae running longitudinally. In some cases they are absent over the upper part of each chamber, a condition observed by Bartenstein and Brand (1937) in *Frondicularia mesoliassica*, which "species" is, in part, very similar if not identical to this.

Measurements of the length and breadth of the chambers in the adult stage reveal that the length:breadth ratio always lies within the range 1:0.8 to 1:1.4. This may be compared with the ratios calculated for *Lingulina longiscata* var. *alpha* (text-fig. 16).

Dimensions: Length up to 0.63 mm.; width up to 0.14 mm.

Variation: In a few specimens, apparently microspheric forms, the ornament is absent from the first two or three chambers. These first-formed chambers, which are longer than broad, are hardly, if at all, chevron-shaped. In view of this, and because of the elongate nature of the aperture, it is considered that these forms are best assigned to the genus *Lingulina* rather than to *Frondicularia*.

Remarks: Terquem (1870, p. 318) recorded this species as *Frondicularia longiscata*, from the Middle Jurassic of France. He stated that it was "rather rare." In the same work, he figured specimens of *Frondicularia nodosaria* Terquem, the first of which (pl. 22, fig. 25a–b) appears to be another example of *Lingulina longiscata*. Jones and Parker (1860) illustrated two specimens which probably belong here, and Issler (1908, pl. 2, fig. 103 only) figured a specimen which appears identical to these. This he called *Frondicularia lanceolata* (Häusler), the original of which is a smooth form. The striae are in many cases difficult to see, and may have escaped Issler's attention. Bartenstein and Brand (1937, pl. 4, fig. 66) show a broken specimen, which they call *Frondicularia mesoliassica* Brand. In the description of this "species," no mention is made of the aperture, and the text-figure (p. 159, text-fig. 6) looks decidedly different from the specimen on the plate.

Material: One hundred thirty-seven specimens from the Upper Lias of northern Lincolnshire.

Lingulina longiscata (Terquem) var. **alpha** Adams, **new variety**

Text-figures 16, 25–26

cf. *Lingulina nodosaria* (Terquem). – BARNARD, 1950, Geol. Soc. London, Quart. Jour., vol. 106, pt. 1, p. 29, text-fig. 16.

Diagnosis: Test fairly small, formed of up to twelve chambers, similar in many respects to *Lingulina longiscata*, but differing as follows: The numerous striae which ornament the test tend to diverge downward. This is caused by the greater width of the test and is not a fundamental difference. The test increases in width fairly rapidly with age, so that the chambers in adult life are considerably broader than long. Internal "siphons" are present in some specimens but are very small; in others they appear to be lacking. In fully grown specimens, the later chambers tend to be reduced in width. The length:width ratio of the adult chambers varies from 1:1.4 to 1:2.9. In text-figure 16, these ratios are compared with those of *Lingulina longiscata*.

Dimensions: Length up to 0.63 mm.; width up to 0.19 mm.

Variation: Irregularities of growth are common. A few increase regularly in size; in others the increase is rapid at first, little further change occurring later. Small chambers are sometimes intercalated amongst the larger.

Remarks: Barnard (1950*b*, p. 29) described and illustrated a form from Byfield which he called *Lingulina nodosaria* (Terquem). The present author feels that this form should probably be included under *Lingulina longiscata* var. *alpha*.

These specimens are regarded as a distinct variety of *Lingulina longiscata* because of the difference in the length:width ratios of the chambers, and because one replaces the other in the succession. There is an interval of 28 feet in which only rare specimens of either type are present. The author cannot explain the bimodal appearance of the graph (text-fig. 16) for this variety. It is not caused by the presence of megalospheric and microspheric forms.

Types: Holotype, B.M.N.H. no. P.43380. Paratypes, B.M.N.H. no. P.43381.

Material: Fifty specimens from the Upper Lias of northern Lincolnshire.

Lingulina tenera Bornemann

Text-figures 17, 22

Lingulina tenera Bornemann, 1854, Liasform. Göttingen, p. 38, pl. 3, fig. 24a–c.

This species and its allied forms will be treated fully in a separate paper. It is introduced here because it exhibits considerable morphological variation, one aspect of

which, namely, the shape of the test, is largely determined by the size of the proloculum. Microspheric individuals have the lower part of the test pointed in outline, whereas megalospheric individuals have the test more parallel-sided.

Measurements made of proloculum size and length of test at different levels of the same core in the Middle Lias seem to indicate that the two generations do not grade into one another. The distribution diagram (text-fig. 17) is typical of the condition found at all levels in the Upper Lias, and is notable mainly for the complete absence of microspheric individuals.

SUMMARY AND CONCLUSIONS

The detailed examination of some Upper Lia genera and species of the Lagenidae illustrates the variation which occurs in their morphology. Application of several different criteria which have been used for the establishment of species, as in the case of *Falsopalmula*, has shown that wherever a large number of specimens are investigated, grading series in different morphological characters can be established. This leads to the conclusion that, in defining a species, care must be taken to indicate the complete range of variation exhibited by its component individuals, otherwise an unnecessary multiplication of specific names will result.

Statistical investigation, involving the measurement of proloculum and test size in thousands of individuals, indicates that the megalospheric form is responsible for by far the greater part of the variation, and an examination of the older literature reveals that the majority of species were erected on megalospheric forms alone. Not only this, but the number of specimens was very often small, numerous cases of "rare," "very rare," or "single specimens" occurring in the literature. Nevertheless, as it is sometimes impossible to find microspheric individuals, it becomes all the more important that the complete range of variation of the megalospheric generation should be given. (It is not suggested that the microspheric forms do not vary, but in most cases their rarity makes it impossible to study their variation.)

It has been averred by Hofker (1951) that trimorphism occurs in the early stages of a family's history. The Lias deposits represent an early period in the evolutionary history of the family Lagenidae (Trias—Recent), and many of its species at that time were highly variable. Measurements have been made of proloculum and test size in species belonging to the genera *Marginulina*, *Lingulina*, *Frondicularia*, *Planularia* and *Falsopalmula* and, although only the first of these is fully discussed in this paper, in no case was any sign of trimorphism observed. In the case of *Marginulina*, very clear dimorphism could be seen in every sample. It may perhaps be suspected from these results that the arrival of the megalospheric generation is followed by the production of a number of similar generations, the later individuals of which tend to increase the size of the proloculum. Forms having very large prolocula are, however, few in number.

It may be that in some genera and species there is no clear-cut distinction between the proloculum size of megalospheric and microspheric individuals. This is suspected in the case of certain species of *Frondicularia* and *Nodosaria*, but further work is required before this can be confirmed.

BIBLIOGRAPHY

BARNARD, T.

1950*a* *Foraminifera from the Lower Lias of the Dorset coast.* Geol. Soc. London, Quart. Jour., vol. 105, pt. 3, pp. 347–391, text-figs. 1–11.

1950*b* *Foraminifera from the Upper Lias of Byfield, Northamptonshire.* Geol. Soc. London, Quart. Jour., vol. 106, pt. 1, pp. 1–36, pls. 1–3, text-figs. 1–17.

1956 – *Some Lingulinae from the Lias of England.* Micropaleontology, vol. 2, no. 3, pp. 271–282, pls. 1–3.

BARTENSTEIN, H.

1948*a* *Untersuchungen zur Systematik und Stratigraphie der Flabellina-gestaltigen Foraminiferen.* Erdöl und Kohle, vol. 1, no. 6, pp. 180–184, text-figs. 1–14.

1948*b* *Taxonomische Abgrenzung der Foraminiferen-Gattungen Palmula Lea, Flabellina d'Orbigny und Falsopalmula n. g., gleichzeitig eine Revision der Jura-Arten von "Flabellina."* Senckenbergiana, vol. 28, no. 4–6, pp. 119–137, pls. 1–2, text-figs. 1–5.

1948*c* *Entwicklung der Gattung Lenticulina (Lenticulina) Lamarck 1804 mit ihren Unter-Gattungen (For.).* Senckenbergiana, vol. 29, no. 1–6, pp. 41–65, pls. 1–6, 11 text-figs.

1949 – *Neoflabellina, nomen novum pour Flabellina d'Orbigny 1839 (foraminifères).* Soc. Géol. France, C. R. Somm., no. 9, pp. 164–166.

BARTENSTEIN, H., AND BRAND, E.

1937 – *Mikro-paläontologische Untersuchungen zur Stratigraphie des nordwest-deutschen Lias und Doggers.* Senckenb. Naturf. Ges., Abh., no. 439, pp. 1–224, pls. 1–20, text-figs. 1–20, 5 tables.

BLAKE, J. F.

1876 – *Class Rhizopoda.* In: TATE, R., AND BLAKE, J. F., *The Yorkshire Lias.* London: J. van Voorst, pp. 449–473, pls. 17–19.

BORNEMANN, J. G.

1854 – *Über die Liasformation in der Umgegend von Göttingen und ihre organischen Einschlüsse.* Berlin: A. W. Schade, pp. 1–77, pls. 1–4.

BRADY, H. B.

1867 – *Foraminifera.* In: MOORE, C., *On the Middle and Upper Lias of the south west of England.* Somersetshire Archaeol. Nat. Hist. Soc., Proc., vol. 13 (1865–1866), pt. 2, pp. 220–236, pls. 1–3.

BROTZEN, F.

1953 – *Problems in the nomenclature of the foraminifera.* Micropaleontologist, vol. 7, no. 2, pp. 35–38.

BUCHNER, P.
1942 – *Die Lingulinen des Golfes von Neapel und der marinen Ablagerungen auf Ischia.* K. Leop.-Carol. Deutsch. Akad. Naturf., Abh. (Nova Acta), new ser., vol. 11, no. 75, pp. 103–145, text-figs. 1–18.

CRICK, W. D., AND SHERBORN, C. D.
1891 – *On some Liassic foraminifera from Northamptonshire.* Northamptonshire Nat. Hist. Soc., Jour., vol. 6, pp. 208–214, 1 pl.

CUSHMAN, J. A.
1940 – *Foraminifera, their classification and economic use.* Ed. 3. Cambridge, Mass.: Harvard University Press, pp. 1–535, pls. 1–31, text-figs., tables, charts; Key, pls. 1–48.

DEFRANCE, M. J. L.
1826 – *Minéralogie et géologie.* In: *Dictionnaire des Sciences Naturelles.* Paris: F. G. Levrault, vol. 41 (pin – plo), pp. 1–558; Atlas, Zoologie: Vers et zoophytes; Conchyliologie et malacologie.

FICHTEL, L. VON, AND MOLL, J. P. C. VON
1798 – *Testacea microscopica aliaque minuta ex generibus Argonauta et Nautilus ad naturam delineata et descripta.* Vienna: Camesina (1803 reprint), pp. 1–124, pls. 1–24.

FRANKE, A.
1936 – *Die Foraminiferen des deutschen Lias.* Preuss. Geol. Landesanst., Abh., new ser., no. 169, pp. 1–138, pls. 1–12.

GLAESSNER, M. F.
1945 – *Principles of micropalaeontology.* Carlton, Victoria: Melbourne University Press, pp. 3–296, pls. 1–14, text-figs. 1–64.

HOFKER, J.
1951 – *The toothplate-foraminifera.* Archives Néerl. Zool., vol. 8 (1947–1951), pt. 4, pp. 353–373, text-figs. 1–30.

ISSLER, A.
1908 – *Beiträge zur Stratigraphie und Mikrofauna des Lias in Schwaben.* Palaeontographica, vol. 55, no. 1, pp. 1–103, pls. 1–7.

JONES, T. R., AND PARKER, W. K.
1860 – *On some fossil foraminifera from Chellaston near Derby.* Geol. Soc. London, Quart. Jour., vol. 16, pp. 452–458, pls. 19–20.

KÜBLER, J., AND ZWINGLI, H.
1866 – *Mikroskopische Bilder aus der Urwelt der Schweiz; Heft II.* Winterthur, Bürgersbibl., Neujahrsbl., pp. 1–28, pls. 1–3.

LOEBLICH, A. R., AND TAPPAN, H.
1950 – *North American Jurassic foraminifera; I – The type Redwater shale (Oxfordian) of South Dakota.* Jour. Pal., vol. 24, no. 1, pp. 39–60, pls. 11–16.

MACFADYEN, W. A.
1936 – *D'Orbigny's Lias foraminifera.* Roy. Micr. Soc. London, Jour., ser. 3, vol. 56, pp. 147–154, pl. 1.

1941 – *Foraminifera from the Green Ammonite beds, Lower Lias, of Dorset.* Roy. Soc. London, Philos. Trans., ser. B, vol. 231, no. 576, pp. 1–73, pls. 1–4, text-figs. 1–6.

MARIE, P.
1941 – *Foraminifères de la Craie: Les foraminifères de la Craie à Belemnitella mucronata du Bassin de Paris.* Paris, Mus. National Hist. Nat., Mém., new ser., vol. 12, fasc. 1, pp. 1–296, pls. 1–37, text-figs. 1–7.

ORBIGNY, A. D'
1826 – *Tableau méthodique de la classe des Céphalopodes.* Ann. Sci. Nat., ser. 1, vol. 7, pp. 96–169, 245–314, pls. 10–17.

1850 – *Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnés.* Paris: V. Masson, vol. 1, pp. 1–392.

PAALZOW, R.
1922 – *Die Foraminiferen der Parkinsoni-Mergel von Heidenheim am Hahnenkamm.* Naturh. Ges. Nürnberg, Abh., vol. 22, pp. 1–35, pls. 1–4.

TERQUEM, O.
1858 – *Mémoire sur les foraminifères du Lias du département de la Moselle; Partie I.* Acad. Imp. Metz, Mém., vol. 39, pp. 563–654 (1–94), pls. 1–4.

1864 – *Troisième mémoire sur les foraminifères du Lias des départements de la Moselle, de la Côte-d'Or, du Rhone, de la Vienne et du Calvados.* Acad. Imp. Metz, Mém., vol. 44 (ser. 2, vol. 11) (1862–1863), pp. 361–438, pls. 7–10.

1870 – *Troisième mémoire sur les foraminifères du Système Oolithique, comprenant les genres Frondicularia, Flabellina, Nodosaria, Dentalina, etc. de la zone à Ammonites parkinsoni de Fontoy (Moselle).* Acad. Imp. Metz, Mém., vol. 51, pp. 299–380 (197–278), pls. 22–29.

WIŚNIOWSKI, T.
1890 – *Mikrofauna iłów ornatowych okolicy Krakowa; Część I – Otwornice górnego Kellowayu w Grojcu.* Akad. Umiej. w Krakowie, Wydz. Mat.-Przyr., Pamiętnik, vol. 17, pp. 181–242, pls. 8–10 (1–3).

ABSTRACT: Cylindroporella sugdeni *and* Cylindroporella arabica *n. spp.*, Arabicodium aegagrapiloides *n. gen., n. sp., and* Polygonella incrustata *n. gen., n. sp., are described as new calcareous algae from the Jurassic and Cretaceous of Arabia.*

New calcareous algae from the Arabian Peninsula

GRAHAM F. ELLIOTT
Iraq Petroleum Company, Ltd.
London

Calcareous algae from the Middle East have been described and listed by the writer in a series of papers (Elliott, 1955*a*, *b*, 1956*a*, *b*, and in press); the present account describes briefly some additions to these forms. I am indebted to the Chief Geologist and Management of the Iraq Petroleum Company, Ltd., for permission to publish this account, and to Dr. F. R. S. Henson, the company's Senior Regional Geologist, who entrusted me with the study of these algae.

DASYCLADACEAE

The dasyclad genus *Cylindroporella* was described by Johnson (1954) from the Cretaceous of Texas, with type *Cylindroporella barnesii* from the Edwards limestone, which is approximately Albian in age. This material occurred as small cylindrical calcareous bodies, rounded or acuminate at the ends, which are considered to be equivalent to the segments of a modern dasyclad such as *Cymopolia*, attached end-to-end in life to form a branching plant, with the segments falling apart after death and before fossilization. In thin section each segment shows a narrow longitudinal central canal and numerous horizontal whorls or verticils composed of about six large internal spherical sporangial cavities joined by short canals to the central cavity. Alternating with these are narrow radial canals extending to the outer surface, where they divide; these represent the original primary infertile branches and subsidiary secondary branches. Sporangia and primary branches are also seen to alternate in position when viewed vertically.

The relative proportions of the internal structures of this alga are distinctive. Two new species are now to be recorded from Arabia, one Upper Jurassic, one Lower Cretaceous, distinguishable from each other and from the type species by size and average proportions. Both were recognised during examination of numerous thin sections of limestones prepared during routine work, and, although weathered specimens are known, the syntypes have been selected from the sections.

Genus CYLINDROPORELLA Johnson, 1954

Cylindroporella sugdeni Elliott, **new species**
Plate 1, figures 1–6

Diagnosis: Large, thick cylindroporelliform segments, agreeing in internal structure with those of *Cylindroporella barnesii*, but with greater diameter of central canal and sporangia and externally, and a greater distance between whorls; it is proportionally shorter and much thicker than the type species (see the table of comparative measurements below).

Locality and horizon: Subsurface Lower Cretaceous of Fahud, Oman; other associated algae are: *Pycnoporidium lobatum* Yabe and Toyama and *Nipponophycus* sp. Lower Cretaceous of Wady Hajar and Wady Ghabar, Hadramaut, in *Orbitolina* limestone of probable Barremian-Aptian age.

Syntypes: The specimens figured in plate 1, figures 1–6, from the subsurface Lower Cretaceous of Fahud, Oman; Geol. Coll. Iraq Petroleum Co., Ltd., London, reg. nos. Fd.438A–F.

Remarks: This species is dedicated to W. Sugden, Divisional Geologist at Qatar, to whom I am indebted for many little algal treasures.

Cylindroporella arabica Elliott, **new species**
Plate 1, figures 13–16

Diagnosis: Small cylindroporelliform segments, agreeing in internal structure with those of *Cylindroporella barnesii* and *Cylindroporella sugdeni*, but usually smaller in all dimensions (see table).

Locality and horizon: Subsurface Upper Jurassic at Dukhan, Qatar, Persian Gulf; other associated algae are: *Clypeina jurassica* Favre, *Clypeina* cf. *hanabatensis* Yabe and Toyama, and *Salpingoporella annulata* Carozzi. Upper Jurassic of Al Hamiah, Coastal Wahidi, Hadramaut, associated with *Salpingoporella annulata* Carozzi and the foraminifer *Valvulinella jurassica* Henson.

Syntypes: The specimens figured in plate 1, figures 13–16, from the subsurface Upper Jurassic of Dukhan, Qatar, Persian Gulf, and from the Upper Jurassic of Al Hamiah, Coastal Wahidi, Hadramaut; Geol. Coll. Iraq Petroleum Co., Ltd., reg. nos. Dk.643A and ZB.808A.

DIMENSIONS (MM.) AND DETAIL OF *Cylindroporella* SPP.

	barnesii	*sugdeni*	*arabica*
Length of segment	2.8 –5.1	3.0+	1.43
Diameter of segment	0.38 –0.55	0.78 –1.14	0.31 –0.57
Diameter of central canal	0.08 –0.14	0.234–0.36	variable 0.052–0.230
Diameter of sporangium	0.134–0.189	0.26 –0.312	0.078–0.156
Number of sporangia per whorl Number of sterile branches per whorl	usually 6 in all three species		
Angle of branches to stem	90° in all three species		
Number of terminal secondary branches	probably 4	? 4	?
Vertical distance between whorls	0.17 –0.187	0.39	0.13

CODIACEAE

Thin sections from the Lower Cretaceous of Oman have revealed the presence of segments of a small alga, apparently a codiacid but differing from *Halimeda* and *Boueina* in the fineness of the internal thread system. It somewhat resembles the Japanese Permian species of *Gymnocodium* figured by Konishi (1952, 1954), but shows no trace of the internal sporangia characteristic of the Chaetangiaceae, to which *Gymnocodium* is considered to be related, and the Cretaceous fossil is here interpreted as a codiacid, a group in which the sporangia are external and only very rarely preserved in fossils.

Genus **Arabicodium** Elliott, **new genus**

Codiaceae segmented like *Halimeda*, but with simple elongate segments not typical for the Recent genus, and with both medullary and cortical threads finer and more uniform.

Type species: Arabicodium aegagrapiloides Elliott, n. sp.; Lower Cretaceous of Oman.

Arabicodium aegagrapiloides Elliott, **new species**
Plate 1, figures 7–10

Description: Cylindrical segments up to 3 mm. in length and 0.80 mm. in diameter; circular in cross-section; ends rounded and occasionally incipiently bifurcated at one end; internally showing a central zone of fine, irregularly twisted longitudinal threads and a marginal zone of irregular, forwardly directed lateral threads widening sharply at their terminations at the outer surface; primary calcification of cortex dense, that of core patchy and irregular; diameter of core approximately half that of whole segment.

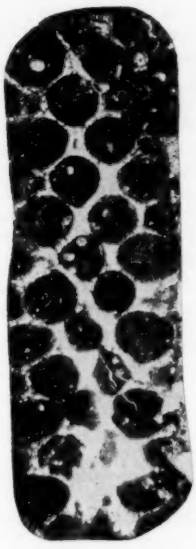
EXPLANATION OF PLATE 1

1–6 *Cylindroporella sugdeni* Elliott, n. sp.
Thin sections, × 28: 1, tangential; 2, 6, oblique vertical; 3–5, transverse. All from subsurface Lower Cretaceous, Fahud, Oman, Arabia; reg. nos. Fd.438A–F.

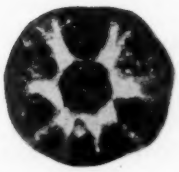
7–10 *Arabicodium aegagrapiloides* Elliott, n. gen., n. sp.
Thin sections, × 20. All from Lower Cretaceous, Hugf area, Oman, Arabia; reg. no. DS.257A.

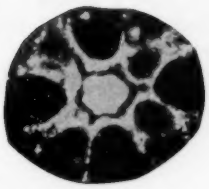
11–12 *Polygonella incrustata* Elliott, n. gen., n. sp.
Thin sections, vertical and transverse in each figure, × 55: 11, Upper Jurassic, Dukhan well no. 28, Qatar, Persian Gulf; 12, subsurface Jurassic, probably Upper Jurassic, Fahud, Oman, Arabia; reg. no. Fd.553A.

13–16 *Cylindroporella arabica* Elliott, n. sp.
Thin sections, × 28: 13, 16, oblique vertical; 14, oblique transverse; 15, transverse. 13–14, Upper Jurassic, Al Hamiah, Coastal Wahidi, Hadramaut; reg. no. ZB.808A; 15–16, Upper Jurassic, Dukhan well no. 28, Qatar, Persian Gulf; reg. no. Dk.643A.


1

2


3

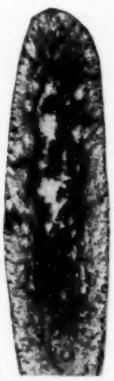

4

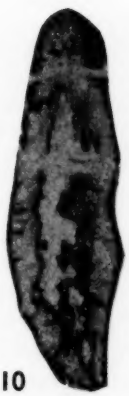
5

6

7

8


9

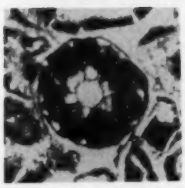

10

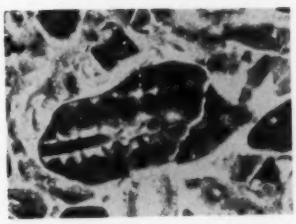
11

12

13

14


15


16

Locality and horizon: Lower Cretaceous of Hugf, Oman; other associated algae are: *Clypeina marteli* Emberger and *Clypeina* cf. *lucasi* Emberger.

Syntypes: The specimens figured in plate 1, figures 7–10, from the Lower Cretaceous of Hugf, Oman; Geol. Coll. Iraq Petroleum Co., Ltd., reg. no. DS.257A.

Remarks: The name refers to the shaggy, hair-like appearance of the plant threads in thin section.

ALGA INCERTAE SEDIS

The thin, encrusting melobesioid *Lithoporella melobesioides* Foslie, familiar in the Tertiary, was recorded from the European Jurassic by Weynschenck (1950) and by de Loriol (1954), and with these records in mind was recognised by the writer in the Upper Jurassic of Qatar, Persian Gulf (Elliott, 1956*a*). In vertical section this Jurassic alga appears as a single layer of proportionally large rectangular cells, like the Tertiary form. However, examination of various thin sections from the Jurassic of the Middle East shows that the transverse section is not a brick-like pattern of rectangular cells, but a honeycomb pattern of polygonal cells. This alga is now described as a new genus and species, and its affinities are discussed.

Genus **Polygonella** Elliott, **new genus**

Calcareous alga composed of thin, encrusting spreads consisting of a single layer of proportionally large cells of polygonal-prismatic shape.

Type species: Polygonella incrustata Elliott, n. sp.; Jurassic of the Middle East.

Polygonella incrustata Elliott, **new species**
Plate 1, figures 11–12

Description: Single-layer spreads of encrusting cells that are rectangular in vertical section and appear transversely as a honeycomb pattern of polygonal cells, of which the most common type is pentagonal; cells 0.065–0.104 mm. high by 0.026–0.033 mm. wide; thickness of cell walls, as preserved, approximately 0.007 mm. Thallus encrusting or sometimes free; often associated with the foraminifer *Nubecularia;* maximum observed diameter (incomplete) 4.0 mm.

Locality and horizon: Subsurface Upper Jurassic of Dukhan, Qatar, Persian Gulf; subsurface Jurassic (probably Upper) of Fahud, Oman; subsurface Jurassic of Terbol, Syria; and elsewhere in the Jurassic of the Middle East. (?)Upper Jurassic of Switzerland; (?)Middle and Upper Jurassic of Austria. Subsurface Lower Cretaceous (Aptian) of Najmah, northern Iraq.

Holotype: The specimen figured in plate 1, figure 12, from the subsurface Jurassic (probably Upper) of Fahud, Oman; Geol. Coll. Iraq Petroleum Co., Ltd., reg. no. Fd.553A.

Remarks: Polygonella may bear the same relation to the typical solenoporoids of the Jurassic as *Lithoporella* does to the melobesioids of the Tertiary. There is a single Lower Cretaceous record of *Polygonella*; it is a simple alga, and the extended range is not surprising.

BIBLIOGRAPHY

ELLIOTT, G. F.

1955*a* – *The Permian calcareous alga Gymnocodium.* Micropaleontology, vol. 1, pp. 83–90, 3 pls.

1955*b* – *Fossil calcareous algae from the Middle East.* Ibid., vol. 1, pp. 125–131, 1 pl.

1956*a* – *Further records of fossil calcareous algae from the Middle East.* Ibid., vol. 2, pp. 327–334, 2 pls.

1956*b* – *Galaxaura (calcareous algae) and similar fossil genera.* Washington Acad. Sci., Jour., vol. 46, pp. 341–343.

[MS.] – *Algues calcaires codiacées fossiles nouvelles ou peu connus d'Iraq.* Soc. Géol. France, Bull. (in press).

JOHNSON, J. H.

1954 – *Cretaceous Dasycladaceae from Gillespie County, Texas.* Jour. Pal., vol. 28, pp. 787–790, pl. 93.

KONISHI, K.

1952 – *Occurrence of Gymnocodium, a Permian alga, in Japan.* Pal. Soc. Japan, Trans. Proc., new ser., no. 7, pp. 215–221, pl. 20.

1954 – *A new species of Gymnocodium and its algal associates in the Permian Kosaki formation of southern Kyusyu, Japan.* Japanese Jour. Geol. Geogr., vol. 25, pp. 1–19, pls. 1–2.

LORIOL, J.-P. DE

1954 – *Observations sur le Purbeckien du mont Vuache (Haute-Savoie).* Arch. Sci. Genève, vol. 7, pp. 118–121.

WEYNSCHENCK, R.

1950 – *Die Jura-Mikrofauna und -flora des Sonnwendgebirges (Tirol).* Schlern-Schriften, Innsbruck, no. 83, pp. 1–32, pls. 1–3, tfs. 1–5, 1 table.

ABSTRACT: *The ostracode fauna of Oligo-Miocene marls and shales from limestone quarries in southern Trinidad is described. Of the sixty species, six are new and one is given a new name. The faunas show relationship to those of the European Aquitanian and Burdigalian and to those of the Tampa/Catahoula and Chipola formations of Florida.*

Oligo-Miocene Ostracoda from southern Trinidad

W. A. VAN DEN BOLD
Bataafsche Petroleum Maatschappy
The Hague

INTRODUCTION

The Ostracoda described in this paper are from shales and marls intercalated between limestones in five quarries in the south of Trinidad:

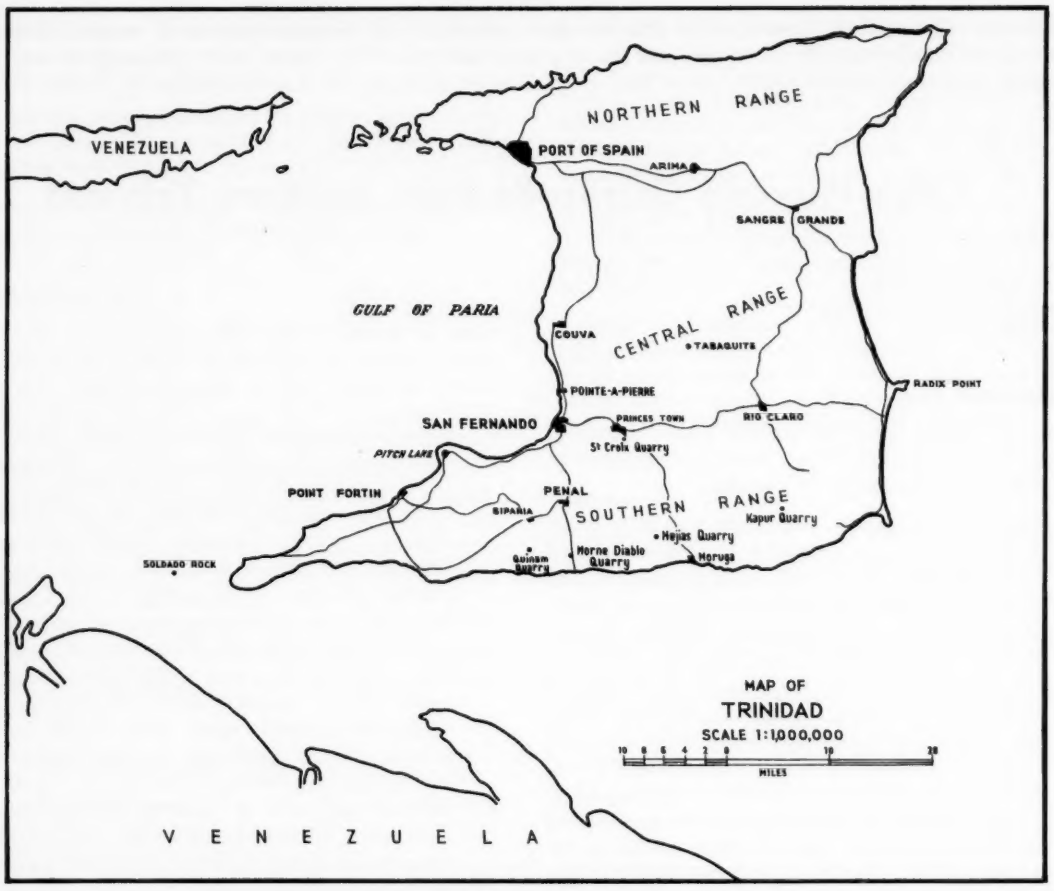
1) Sainte Croix Quarry, about one-half mile south of Princes Town (see text-fig. 1). It was sampled by Mühlemann (RM 14873, an auger hole drilled to 19 feet and sampled almost every foot), Kugler, Rohr and Bronnimann (160360), Hutchison (AGH 5264–5274), and Strasser (SE 352). The Sainte Croix Quarry is the type locality of Waring's Ste. Croix formation (Waring, 1926, pp. 48–52), but the Ste. Croix limestone is at present considered to be no more than the reef facies of part of the Brasso formation (Renz, 1942, p. 554). Smaller foraminifera have been described by Cushman and Renz (1947), mollusks by Rutsch (1934). These authors correlated the Ste. Croix limestone with the Esmeralda (lower) member of the Brasso formation. Rutsch (1934) suggested correlation with deposits in Italy that were considered at the time to be Burdigalian and Helvetian in age, but which, according to Drooger (1954), are the equivalent of the upper Aquitanian of Bordeaux. In the Ste. Croix limestone, Bronnimann (1950) found *Globigerinatella insueta* Cushman and Stainforth, which also occurs in the Esmeralda member of the Brasso formation of Trinidad, in the upper Acostian of Falcón (Venezuela), and in the *Amphistegina* and *Operculinoides* subsurface zones of Louisiana (Akers, 1955). This suggests correlation of the Ste. Croix limestone with the lower part of the Brasso formation, with part of the Agua Salada group, and with part of the Tampa/Catahoula formation in Florida (Puri, 1953*b*). Drooger (1956) places the *Globigerinatella insueta* zone in the Helvetian.

2) Morne Diablo Quarry, five miles south of Penal. This is a large block of limestone occurring as a slip-mass in younger Miocene clays. It was sampled by Kugler (K 2668A, 2667), Mühlemann (RM 13616), Kugler and Bronnimann, and Renz, Bronnimann and Bolli. From the Morne Diablo Quarry, Drooger (1952) determined *Miogypsina bronnimanni*, which in his phylogenetic scheme (Drooger, 1952, p. 72, text-fig. 17) should be placed above the upper Aquitanian form *Miogypsina gunteri* (Middle Oligocene of America). The transitional form *Miogypsina tani–bronnimanni* has been found in the Kapur Quarry in the *Globigerina dissimilis* zone. This would date the Morne Diablo limestone as contemporaneous with or slightly younger than the *Globigerina dissimilis* zone, with a possible Burdigalian age. However, in a later publication (1956), Drooger tentatively extends the range of *Globigerina dissimilis* into the Helvetian.

3) Mejias Quarry, four miles northwest of Moruga. There is some confusion about the spelling of this name: Renz (1942, p. 549) uses the name "Mijas Quarry," but writes "Mejas limestone" in his stratigraphic table. Drooger (1952, p. 30) writes "Meijas Quarry." On the Government Ward sheet, the road to the quarry is called "Cunam Quarry road," and Liddle (1946, p. 739) appears to refer to it as the "Ulen Quarry." It was sampled by Renz. This limestone lies within the *Globigerina dissimilis* zone, and appears to be slightly older than the Kapur limestone (Drooger, 1952).

4) Kapur Quarry, twelve and one-half miles south of Rio Claro, along the Guayaguayare road. It was sampled by Leuzinger (Lz 3468).

5) Quinam Quarry, four miles south of Siparia. It was sampled by Higgins (Hg 112). This limestone has been correlated by palaeontologists of the Trinidad Oil Company Ltd. (formerly T.L.L.) with the Morne Diablo limestone.



TEXT-FIGURE 1

In text-figure 2, the approximate position of the limestones in the stratigraphic sequence is given. The Oligo-Miocene boundary has been placed provisionally at the base of the *Globigerinatella insueta* zone, although the possibility of the Aquitanian lying below this boundary is indicated. One could go to the other extreme and include the whole of the *Globigerina dissimilis* zone in the Miocene, as was done by Drooger (1956). In Trinidad the actual boundary probably lies somewhere within the *Globigerina dissimilis* zone, but there is no palaeontological boundary that seems to coincide with it, so that its position remains uncertain in this region.

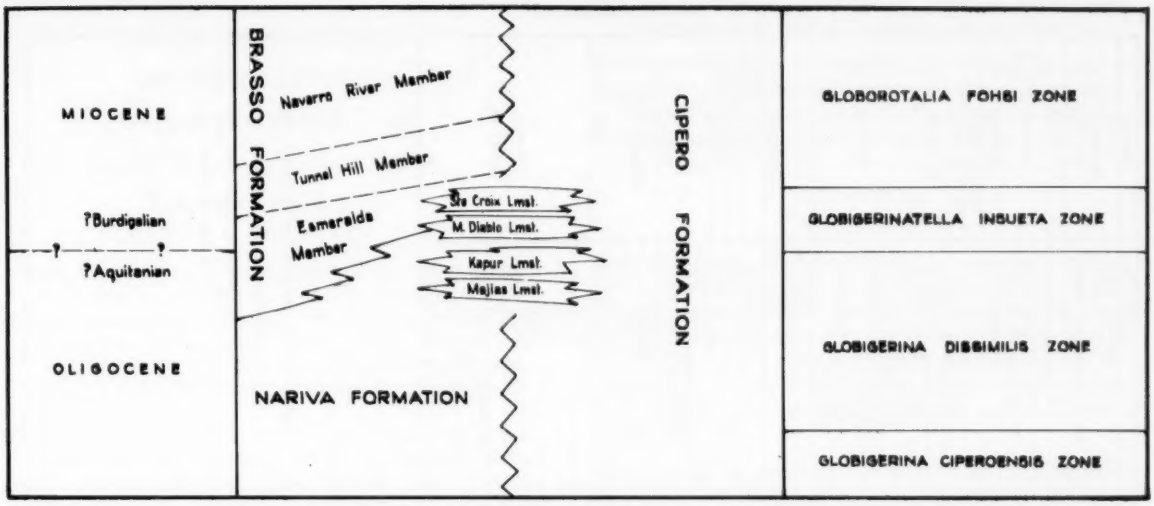
There are only a few species of Ostracoda that occur in both the Antillean and the European Tertiary. They are:

Aurila deformis (Reuss): Aquitanian-Tortonian (Reuss, 1850; Key, 1955);
Aurila trigonula (Jones): Aquitanian-Burdigalian, southwestern France (Key, 1955); Pliocene, England (Jones, 1857);
Hermanites haidingeri (Reuss): Upper Oligocene (Bosquet, 1852); Recent (Ruggieri, 1953*c*);
Hemicytherura videns (Müller): Upper Aquitanian (Key, 1955); Recent (Ruggieri, 1953*a*);
Echinocythereis asperrima (Reuss): Lower Oligocene (Bornemann, 1855); Recent (Ruggieri, 1953*b*);
Possibly also *Xestoleberis glabrescens* (Reuss): Stampian-Tortonian (Reuss, 1850; Key, 1955).

These species seem to indicate a possible upper Aquitanian—Tortonian age for both the Morne Diablo and the Ste. Croix limestones.

In the Gulf Coast Tertiary, a number of species, listed below, have been found in the following formations:

Cyprideis mayi (Stephenson): Alum Bluff;
Aurila deformis (Reuss): Alum Bluff, Tampa/Catahoula (personal observation);



TEXT-FIGURE 2
POSITION OF OLIGO-MIOCENE LIMESTONES IN TRINIDAD STRATIGRAPHY

Orionina bermudae (Brady): Alum Bluff and younger; *Caudites sellardsi* (Howe and Neill): Choctawhatchee; *Cytheropteron leonensis* Puri: Choctawhatchee; *?Costa macerta* (Stephenson): Tampa/Catahoula.

They suggest that the Ste. Croix limestone is roughly the equivalent of the Tampa/Catahoula or Alum Bluff. The Morne Diablo limestone appears to be slightly older (*Orionina bermudae* and *Caudites sellardsi* are absent, but, on the other hand, the Morne Diablo contains *Cytheropteron leonensis*). The Quinam limestone may be slightly younger in age, as witnessed by the presence of *Basslerites berchoni* (Brady), of which the oldest occurrence elsewhere in Trinidad is in the *Globorotalia fohsi* zone.

However, in this connection it is of interest to record the occurrence of *Basslerites berchoni* (Brady), *Cativella* cf. *navis* (Coryell and Fields), *Cytherura hermesi* van den Bold, *Orionina bermudae* (Brady), *Puriana* aff. *puella* (Coryell and Fields), *Pellucistoma kendengensis* (Kingma), and *Pellucistoma magniventra* Edwards in Colombia (Cienega de Oro section, Lower Magdalena Valley), in beds containing the larger foraminifera *Heterostegina israelskyi* Gravell and Hanna and *Operculinoides ellisorae* Gravell and Hanna, which were originally described from the *Heterostegina* subsurface zone of the American Gulf Coast (Gravell and Hanna, 1937). The equivalent of these beds should be found in the lower part of the Tampa/Catahoula of Florida (Puri, 1953*b*).

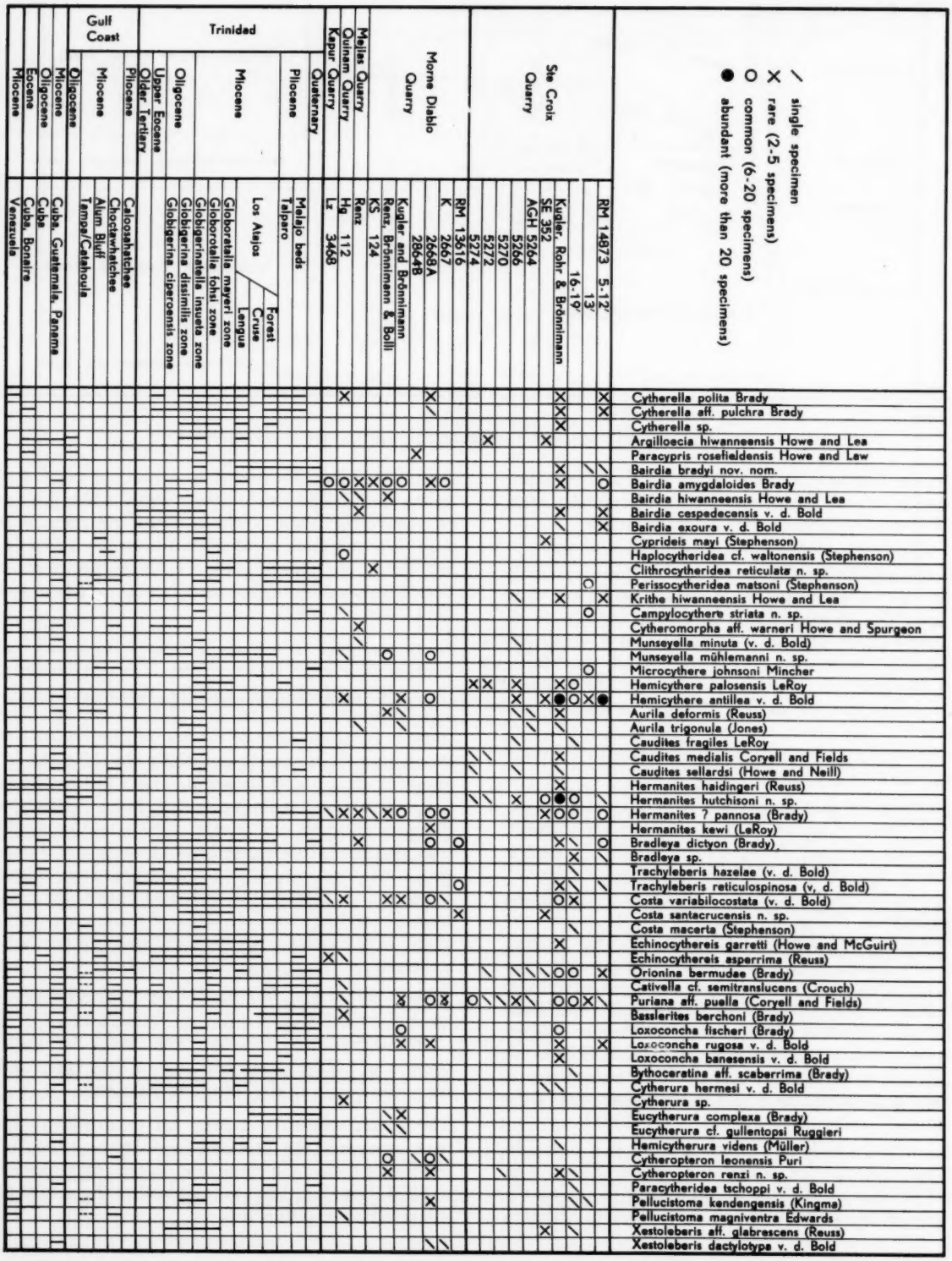
Below these beds in Colombia there is a brackish-water intercalation containing *Perissocytheridea matsoni* (Stephenson). This would appear to extend the range of the species listed above (at least in northern South America) downward to a horizon somewhat below the *Globigerinatella insueta* zone. These species may have had their origin in South America, and may have migrated northward during the Miocene. On the range chart (Table 1), these species have been indicated by dotted lines in the section of the Gulf Coast.

In this respect it is also of interest to point out another difference between the ostracode fauna of the Gulf Coast Miocene and the Miocene of northern South America. In the Gulf Coast Miocene there is an abundance of species and individuals of the genera "*Cytherideis*" (especially the "*Cytherideis*" *ashermani* group) and *Cytheretta*, which still persist in Cuba and Guatemala (van den Bold, 1946). In Panama (Coryell and Fields, 1937), in Venezuela (van den Bold, 1950*a*), and in Colombia and Trinidad, these forms are absent. The writer has had an opportunity to study extensive sample collections from Colombia, especially from the Llanos region, of the Concesionaria de Petroleo Shell Condor S.A. in Bogotá.

Three species from the Ste. Croix beds have been identified with species from the Plio-Pleistocene of California (LeRoy, 1943). The range of these species in California is not known, however, and they also occur in the Trinidad Pliocene.

The writer wishes to express his gratitude to the management of the Trinidad Oil Company Ltd. for the use of their collections, and to the management of Shell Trinidad, Ltd., for permitting the results of this study to be published.

TABLE 1


/ single specimen
X rare (2-5 specimens)
O common (6-20 specimens)
● abundant (more than 20 specimens)
Gulf Coast
Trinidad
Quaternary
Pliocene
Miocene
Oligocene
Eocene
Miocene
Pliocene
Older Tertiary
Upper Eocene
Oligocene
Miocene
Oligocene
Miocene
Oligocene
Miocene
Cuba
Cuba, Bonaire
Venezuela
Malejo beds
Talparo
Los Atajos
Forest
Cruse
Lengua
Globorotalia mayeri zone
Globorotalia fohsi zone
Globigerinatella insueta zone
Globigerina distimilis zone
Globigerina ciperoensis zone
Caloosahatchee
Choctawhatchee
Alum Bluff
Tampa/Catahoula
Kapur Quarry
Quinam Quarry
Mejias Quarry
Morne Diablo Quarry
Ste Croix Quarry
RM 14873
5-12'
13'
16-19'
Kugler, Rohr & Brönnimann
SE 352
AGH 5264
5266
5270
5272
5274
RM 13616
K
2667
2668A
2864B
Kugler and Brönnimann
Renz, Brönnimann & Bolli
KS 124
Renz
Hg 112
Lz 3468
Cytherella polita Brady
Cytherella aff. pulchra Brady
Cytherella sp.
Argilloecia hiwanneensis Howe and Lea
Paracypris rosefieldensis Howe and Law
Bairdia bradyi nov. nom.
Bairdia amygdaloides Brady
Bairdia hiwanneensis Howe and Lea
Bairdia cespedecensis v. d. Bold
Bairdia exoura v. d. Bold
Cyprideis mayi (Stephenson)
Haplocytheridea cf. waltonensis (Stephenson)
Clithrocytheridea reticulata n. sp.
Perissocytheridea matsoni (Stephenson)
Krithe hiwanneensis Howe and Lea
Campylocythere striata n. sp.
Cytheromorpha aff. warneri Howe and Spurgeon
Munseyella minuta (v. d. Bold)
Munseyella mühlemanni n. sp.
Microcythere johnsoni Mincher
Hemicythere palosensis LeRoy
Hemicythere antillea v. d. Bold
Aurila deformis (Reuss)
Aurila trigonula (Jones)
Caudites fragiles LeRoy
Caudites medialis Coryell and Fields
Caudites sellardsi (Howe and Neill)
Hermanites haidingeri (Reuss)
Hermanites hutchisoni n. sp.
Hermanites ? pannosa (Brady)
Hermanites kewi (LeRoy)
Bradleya dictyon (Brady)
Bradleya sp.
Trachyleberis hazelae (v. d. Bold)
Trachyleberis reticulospinosa (v. d. Bold)
Costa variabilocostata (v. d. Bold)
Costa santacrucensis n. sp.
Costa macerta (Stephenson)
Echinocythereis garretti (Howe and McGuirt)
Echinocythereis asperrima (Reuss)
Orionina bermudae (Brady)
Cativella cf. semitranslucens (Crouch)
Puriana aff. puella (Coryell and Fields)
Basslerites berchoni (Brady)
Loxoconcha fischeri (Brady)
Loxoconcha rugosa v. d. Bold
Loxoconcha banesensis v. d. Bold
Bythoceratina aff. scaberrima (Brady)
Cytherura hermesi v. d. Bold
Cytherura sp.
Eucytherura complexa (Brady)
Eucytherura cf. gullentopsi Ruggieri
Hemicytherura videns (Müller)
Cytheropteron leonensis Puri
Cytheropteron renzi n. sp.
Paracytheridea tschoppi v. d. Bold
Pellucistoma kendengensis (Kingma)
Pellucistoma magniventra Edwards
Xestoleberis aff. glabrescens (Reuss)
Xestoleberis dactylotypa v. d. Bold

SYSTEMATIC DESCRIPTIONS

Order OSTRACODA

Suborder PLATYCOPA

Family CYTHERELLIDAE

Genus CYTHERELLA Jones, 1849

Cytherella polita Brady
Plate 1, figure 2a–b

Cytherella polita BRADY, 1869, *Les fonds de la mer*, vol. 1, p. 161, pl. 19, figs. 5–7. – MÜLLER, 1912, *Das Tierreich*, p. 396.

?Cytherella polita Brady. – GUPPY, 1893, Trinidad Field Nat. Club, Jour., vol. 1, p. 28. – GUPPY, 1903, Victoria Inst. Trinidad, Proc., vol. 2, p. 2. – CHAPMAN, 1926, New Zealand, Geol. Survey, Pal. Bull. no. 11, p. 105, pl. 22, fig. 12.

Not *Cytherella polita* Brady. – BRADY, 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 172, pl. 43, fig. 5a–c; pl. 44, fig. 1a–g. – CHAPMAN, 1916, Victoria, Geol. Survey, Rec., vol. 3, p. 379, pl. 75, fig. 45. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 60, pl. 3, fig. 2a–c.

Cytherella sp., VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 80, pl. 18, fig. 1a–c.

?Cytherella lata Brady. – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 218, pl. 3, fig. 6a–b.

Brady's original figures show the same constriction in the upper middle portion of the carapace as the Venezuelan and Trinidadian specimens. Most of the later determinations of *Cytherella polita* appear to have been based on the Challenger figures rather than on the original ones, which is not surprising, as the "Fonds de la mer" is very rare and difficult to obtain. In the writer's collection from Trinidad, the range of the species is from Upper Eocene to Recent. It is believed therefore that the species called *Cytherella lata* Brady by Key is the same species. It occurs in the Ste. Croix and Morne Diablo Quarries. Length 0.51 mm.; height 0.35 mm.; width 0.25 mm.

Cytherella sp. aff. **Cytherella pulchra** Brady
Plate 1, figure 1

?Cytherella pulchra BRADY, 1866, Zool. Soc. London, Trans., vol. 5, p. 361, pl. 62, fig. 1a–d. – CHAPMAN, 1916, Victoria, Geol. Survey, Rec., vol. 3, p. 379, pl. 75, fig. 46; 1926, New Zealand, Geol. Survey, Pal. Bull. no. 11, p.106, pl. 22, fig. 14.

?Cytherella pulchra Brady(?). – BRADY, 1869, *Les fonds de la mer*, vol. 1, p. 152.

Cytherella pulchra Brady. – BRADY, 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 174, pl. 44, fig. 3a–b. – MÜLLER, 1912, *Das Tierreich*, p. 390. – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 218, pl. 3, fig. 8a–b; pl. 6, fig. 1.

?Cytherella sp., HOWE AND CHAMBERS, 1935, Louisiana, Dept. Cons., Geol. Bull. no. 5, p. 6, pl. 4, figs. 17–18; pl. 5, figs. 11–12. – BERGQUIST, 1942, Mississippi, State Geol. Survey, Bull. no. 49, p. 105, pl. 11, fig. 1.

Cytherella sp., Howe and Chambers. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 60, pl. 2, fig. 4.

In Trinidad this species ranges from Upper Eocene to Recent; it was at first believed to be the male of *Cytherella polita* Brady. It occurs in the Ste. Croix and Morne Diablo Quarries. Length 0.77 mm.; height 0.49 mm.

Cytherella sp.
Plate 1, figure 3

Carapace ovate, highest behind the middle. Anterior end rounded, dorsal and ventral margin convex, posterior end rounded. Right valve overlapping the left along the entire periphery, strongest in the anterior part of the dorsal margin, where the left valve is slightly depressed, and in the posterior part of the ventral margin. Widest slightly behind the middle. Length 0.72 mm.; height 0.48 mm.

This species ranges from the Oligocene(?) (*Globigerina dissimilis* zone) to the Pliocene (Talparo formation). It has been found in the Ste. Croix and Mejias Quarries.

Suborder PODOCOPA

Family CYPRIDIDAE

Subfamily CANDONINAE

Genus PARACYPRIS Sars, 1866

Paracypris rosefieldensis Howe and Law
Plate 1, figure 4

Paracypris rosefieldensis HOWE AND LAW, 1936, Louisiana, Dept. Cons., Geol. Bull. no. 7, p. 30, pl. 3, figs. 9–11. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 66, pl. 6, fig. 4.

This species is very close to *Paracypris choctawhatcheensis* Puri (1953*b*, p. 227, pl. 1, figs. 10–12, text-fig. 2a–b, d), but it does not possess the strong flange in the anterodorsal margin of the left valve mentioned by Puri. *Paracypris rosefieldensis* has been found in the Morne Diablo Quarry. Length 0.90 mm.; height 0.38 mm.

Subfamily PONTOCYPRIDINAE

Genus ARGILLOECIA Sars, 1866

Argilloecia hiwanneensis Howe and Lea

Argilloecia hiwanneensis HOWE AND LEA, 1936, in HOWE AND LAW, Louisiana, Dept. Cons., Geol. Bull. no. 7, p. 25, pl. 1, figs. 25–29. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 64, pl. 3, fig. 7. – KINGMA, 1948, *Contribution to the knowledge of the Young Caenozoic Ostracoda*, p. 67, pl. 6, fig. 16.

This species occurs in the Ste. Croix Quarry and is common in the upper Esmeralda member of the Brasso formation. Length 0.43 mm.; height 0.20 mm.; width 0.15 mm.

Family BAIRDIIDAE

Genus BAIRDIA McCoy, 1844

Bairdia bradyi van den Bold, **new name**
Plate 1, figure 5

Bairdia foveolata BRADY, 1868, *Les fonds de la mer*, vol. 1, p. 56, pl. 7, figs. 4–6; 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 55, pl. 8, figs. 1a–f, 2a–f.

?Bairdia foveolata Brady. – CHAPMAN AND CRESPIN, 1928, Victoria, Geol. Survey, Rec., vol. 5, p. 169.

Not *Bairdia foveolata* BOSQUET, 1852, Acad. Roy. Sci. Lett. Belgique, Mém. Cour., vol. 24, p. 21, pl. 1, fig. 5a–d.

As the name *Bairdia foveolata* Brady, 1868, is preoccupied by *Bairdia foveolata* Bosquet, 1852 (= *Monsmirabilia foveolata* (Bosquet)), the name *Bairdia bradyi* is proposed here. This species has been found in the Ste. Croix Quarry, but is more common in the higher part of the Miocene and still occurs in the seas around Trinidad. Length 1.02 mm.; height 0.76 mm.

Bairdia amygdaloides Brady
Plate 1, figure 6a–b

Bairdia amygdaloides BRADY, 1866, Zool. Soc. London, Trans., vol. 5, p. 364, pl. 57, fig. 6. – SEGUENZA, 1884, Naturalista Siciliano, vol. 3, p. 257. – GUPPY, 1893, Trinidad Field Nat. Club, Jour., vol. 1, p. 28. – NEVIANI, 1906, Soc. Geol. Ital., Boll., vol. 25, fasc. 1, p. 188.

Bairdia amygdaloides Brady. – BRADY, 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 54, pl. 9, fig. 5; pl. 10, fig. 2. – NEVIANI, 1928, Accad. Pont. Sci. Nuovi Lincei, Mem., ser. 2, vol. 11, p. 28. – CHAPMAN AND CRESPIN, 1928, Victoria, Geol. Survey, Rec., vol. 5, p. 169. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 70, pl. 1, fig. 4. – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 219, pl. 4, fig. 1.

Nesidea amygdaloides (Brady). – MÜLLER, 1912, *Das Tierreich*, p. 247.

?Bairdia dewattrei BRADY, 1868, *Les fonds de la mer*, vol. 1, p. 199, pl. 27, figs. 17–18.

Further references will be found in Chapman (1926, p. 100) and Neviani (1928, p. 28). Guppy (1893) reported this species from the Naparima beds and the Pointe-à-Pierre Ditrupa beds (Cipero and Brasso formations). It has been found in the Ste. Croix, Morne Diablo and Kapur Quarries. Its range appears to be Oligocene (*Globigerina ciperoensis* zone) to Recent. Length 0.86 mm.; height 0.55 mm.

Bairdia hiwanneensis Howe and Lea

Bairdia hiwanneensis HOWE AND LEA, 1936, in HOWE AND LAW, Louisiana, Dept. Cons., Geol. Bull. no. 7, p. 27, pl. 2, fig. 9; pl. 3, fig. 1.

This species has been found rarely in the Morne Diablo, Mejias and Quinam Quarries. Length 0.95 mm.; height 0.58 mm.

Bairdia cespedecensis van den Bold

Bairdia cespedecensis VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 73, pl. 1, fig. 8; 1957, Micropaleontology, vol. 3, no. 1, p. 6, pl. 2, fig. 5a–b.

This species ranges from the Upper Cretaceous to the Miocene. It is present in the Ste. Croix and Mejias Quarries.

Bairdia exoura van den Bold

Bairdia exoura VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 1, p. 6, pl. 2, fig. 6.

Family CYTHERIDAE

Subfamily CYTHERIDEINAE

Genus CYPRIDEIS Jones, 1857

Cyprideis mayi (Stephenson)
Plate 4, figure 2

Anomocytheridea mayi STEPHENSON, 1938, Jour. Pal., vol. 12, p. 140, pl. 23, fig. 24; text-fig. 9.

Only a few specimens of this species have been found in the Ste. Croix Quarry. Length 0.48 mm.; height 0.29 mm.

Genus HAPLOCYTHERIDEA Stephenson, 1936

Haplocytheridea sp. cf. **Haplocytheridea waltonensis** (Stephenson)
Plate 1, figure 7

Cytheridea (Leptocytheridea) waltonensis STEPHENSON, 1938, Jour. Pal., vol. 12, p. 140, pl. 23, fig. 13; text-fig. 15. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 82, pl. 8, fig. 3. – SMITH, 1941, Amer. Assoc. Petr. Geol., Bull., vol. 25, p. 279.

Haplocytheridea waltonensis (Stephenson). – PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 234, pl. 2, figs. 6–8; text-fig. 4g, h.

The specimens from Trinidad differ from *Haplocytheridea waltonensis* in having a finely denticulate anterior margin, whereas Stephenson mentions only a few larger spines. The form of overlap of the left valve also seems to be slightly different. The species occurs in the Quinam Quarry (Hg 112), and in the upper part of the Esmeralda member of the Brasso formation. Length 0.74 mm.; height 0.46 mm.

Genus CLITHROCYTHERIDEA Stephenson, 1936

Clithrocytheridea reticulata van den Bold, **new species**
Plate 4, figure 3a–c

?Cytheropteron sp. *B*, KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 226, pl. 5, fig. 7.

Carapace small, ovate, ornate, highest in front of the middle. Anterior end rounded; dorsal margin gently arched; posterior end produced and rather sharply angled subventrally, posterodorsal slope in the left valve straight, in the right concave; ventral margin slightly sinuate.

Left valve overlapping the right along the entire dorsal and posterodorsal margin. Anterodorsal margin in the right valve slightly depressed; dorsal margin straight, but partly obscured by a low arched ridge. Ventral margin partly obscured by a sharp ventral ridge, which continues as a faint ridge around the posterior end to join the dorsal ridge. Surface covered with deep angular and rounded pits, in the middle of the carapace in vertical rows, in the ventral part parallel to the ventral ridge. One row of pits forms a slight submedian vertical sulcus.

In dorsal view the carapace is regularly spindle-shaped, except for the slightly projecting ventral ridge behind the middle. Hinge typical for the genus. Length 0.33 mm.; height 0.19 mm.; width 0.19 mm.

As far as the writer is aware, no ornamented species of *Clithrocytheridea* have heretofore been described from the Miocene, although some of the Paleocene and Lower Eocene species show some similarity to this one. The present species is common today in the seas around Trinidad, where it occurs only in near-shore facies. It has also been found in the *Globorotalia fohsi* zone of the Brasso formation and in the Morne Diablo Quarry. This species cannot be identified with certainty with Key's form, as no description was given, and the photograph is rather poor.

Holotype: A complete carapace from the Navarro member of the Brasso formation, *Globorotalia fohsi* zone, Rohr locality 21, Caparo River at Brasso village, near the junction of the Brasso-Tamano road and the Caparo Valley road, Trinidad, B.W.I. (Trinidad Government cadastral coordinates: N 307,200 links; E 435,280 links); U. S. Nat. Mus. no. 562048.

Genus PERISSOCYTHERIDEA Stephenson, 1938

Perissocytheridea matsoni (Stephenson)
Plate 3, figure 3

Cytheridea? matsoni STEPHENSON, 1935, Louisiana, Dept. Cons., Geol. Bull. no. 6, p. 192, pl. 5, figs. 1–2, 7–8.

Perissocytheridea matsoni (Stephenson). – STEPHENSON, 1938, Jour. Pal., vol. 12, p. 145, pl. 24, figs. 3–4; text-figs. 4, 7, 11. – MINCHER, 1941, Jour. Pal., vol. 15, p. 343, pl. 47, fig. 3. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 84, pl. 9, fig. 9.

This species occurs abundantly in a narrow band in the Ste. Croix Quarry (RM 14873, at 13 feet). It has also been found in the Pliocene Talparo formation, and in Recent brackish-water deposits around Trinidad. Length 0.49 mm.; height 0.36 mm.

Genus KRITHE Brady, Crosskey and Robertson, 1874

Krithe hiwanneensis Howe and Lea

Krithe hiwanneensis HOWE AND LEA, 1936, in HOWE AND LAW, Louisiana, Dept. Cons., Geol. Bull. no. 7, p. 72, pl. 5, figs. 32–34. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 76, pl. 4, fig. 20.

In Trinidad this species occurs in the *Globigerina dissimilis* zone, in the *Globigerinatella insueta* zone, and in the lower part of the *Globorotalia fohsi* zone. Only a few specimens have been found in the Ste. Croix Quafry, none in the others. The facies of these limestones is apparently unfavourable to species of this genus, which occur in large numbers in the Cipero and Lengua formations. Length 0.49 mm.; height 0.30 mm.

Subfamily MICROCYTHERINAE

Genus MICROCYTHERE Müller, 1894

Microcythere johnsoni Mincher
Plate 4, figure 1

Microcythere johnsoni MINCHER, 1941, Jour. Pal., vol. 15, p. 344, pl. 47, fig. 4. – PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 290. – SWAIN, 1955, Jour. Pal., vol. 29, p. 641, pl. 63, fig. 2a–c; pl. 64, fig. 7; text-fig. 39 (3).

This species has been found near the coast in the Gulf of Paria, and a short distance upstream in some rivers. It is quite common in a narrow band in the Ste. Croix Quarry (RM 14873, at 13 feet). Length 0.40 mm.; height 0.19 mm.

Subfamily CYTHERINAE

Genus CAMPYLOCYTHERE Edwards, 1944

Campylocythere striata van den Bold, **new species**
Plate 3, figure 2a–d

Carapace elongate, ovate, highest in front of the middle. Anterior end rounded, anterodorsal margin in the right valve slightly depressed; dorsal margin gently convex in the right valve, slightly sinuate in the left; posterior end bluntly rounded below, concave above, rather short; ventral margin convex. Left valve overlapping the right at the greatest height and in the posterior two-thirds of the dorsal margin. Surface of the valves ornamented with about seven faint longitudinal ridges. The lower three coalesce and are slightly more raised than the others.

Hinge in the right valve with a small anterior tooth, placed below the depression in the margin, and a small elongate socket, which continues with a slight curve into a long, narrow groove, bordered posteriorly by a large, blunt tooth. In the left valve there is a small anterior socket with an adjacent small round tooth, which is connected to the dorsal ridge; this ridge is low and narrow and curves around the posterior socket, which is open to the interior. Marginal area of moderate width; line of concrescence and inner margin not quite

coincident in the anterior end. Pore canals fairly numerous, tending to stand in groups. Length 0.52 mm.; height 0.29 mm.; width 0.21 mm.

Previously described species of this genus have no longitudinal ribs but are punctate, although the surface pits of *Campylocythere concinnoidea* Swain (1955, pp. 636–637, pl. 62, fig. 5a–d; text-figs. 36a, 39 (8a–b)) are longitudinally arranged in the ventral part.

This species has been found in a narrow zone in the Ste. Croix Quarry (RM 14873, at 13 feet), and occurs also in brackish water near the shore in the Gulf of Paria.

Holotype: A complete specimen from the Ste. Croix Quarry; U. S. Nat. Mus. no. 562047.

Genus CYTHEROMORPHA Hirschmann, 1909

Cytheromorpha sp. aff. **Cytheromorpha warneri** Howe and Spurgeon
Plate 3, figure 5a–b

Cytheromorpha warneri HOWE AND SPURGEON, 1935, in HOWE, Florida, Dept. Cons., Geol. Bull. no. 13, p. 11, pl. 2, figs. 5, 8–9; pl. 4, fig. 4. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 105; 1950, Jour. Pal., vol. 24, p. 86.

Cytheromorpha cf. *C. warneri* Howe and Spurgeon. – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 49, pl. 7, figs. 18–19.

This species is so close to *Cytheromorpha warneri* that there would be no reason to doubt the identification, were it not for the fact that the range of this species in Trinidad is Upper Eocene to Oligocene (*Globigerina dissimilis* zone). It has not been found in the Miocene, whereas *Cytheromorpha warneri* has so far been described only from the Miocene (United States Atlantic Coastal Plain, Florida, Cuba, and Venezuela). The species in the present material has been found in the Mejias Quarry. Length 0.40 mm.; height 0.23 mm.; width 0.20 mm.

Genus MUNSEYELLA van den Bold, 1957

Toulminia Munsey, 1953 (not *Toulminia* Zittel, 1878).

Munseyella mühlemanni van den Bold, **new species**
Plate 3, figure 4a–c

Carapace small, highest near the anterior end, where the anterior cardinal angle in the left valve projects over the depressed anterodorsal margin of the right. Anterior end obliquely and broadly rounded, with a broad, flat rim; dorsal margin gently convex, very faintly angled in the middle; ventral margin nearly straight, slightly sinuate, converging very gently posteriorly; posterior end vertically truncate, with two blunt, projecting spines. Posterior cardinal angle projecting. Surface of the valves covered with rather large, rounded pits, which are arranged in oblique rows in the posterodorsal portion of the carapace. Usually there is a row of large pits parallel to the anterior rim. A dorsal and a ventral ridge are faintly indicated.

Hinge similar to *Toulminia hyalokystis* Munsey (1953, text-fig. 1). In addition to variation in the pitting, there is rather strong variation in the size. The Morne Diablo specimens are much smaller than those in younger formations. The species ranges from the lower Cipero (*Globigerina ciperoensis* zone) to the Cruse formation.

Dimensions:	Length	Height	Width
Morne Diablo specimens:	0.30 mm.	0.16 mm.	0.14 mm.
Cruse specimens:	0.46 mm.	0.26 mm.	0.21 mm.

This species has been found in the Morne Diablo and Quinam Quarries, and in Sullivan hole 204, about 2 miles south of the Rio Claro-Mayaro road and about 4½ miles east of Rio Claro, Trinidad.

Holotype: A complete carapace from the Point d'Or beds (approximately Middle Miocene, equivalent to the Lengua formation, *Globorotalia menardii* zone), east of the Pitch Lake, southwestern Trinidad, B.W.I.; U.S. Nat. Mus. no. 562049.

Munseyella minuta (van den Bold)

Cytheromorpha minuta VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 105, pl. 14, fig. 12.

?Cytheromorpha subminuta PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 276, pl. 6, figs. 9–10; text-fig. 11i–j.

One specimen has been found in the Mejias Quarry. Puri's figures do not permit detailed comparison, but the writer has found specimens of *Munseyella minuta* in a collection of Ostracoda from the Florida Miocene, and it is believed to be quite possible that *Cytheromorpha subminuta* Puri is the same species. This species occurs also in the Cipero, Brasso, Lengua and Cruse formations. Length 0.32 mm.; height 0.19 mm.; width 0.15 mm.

Subfamily HEMICYTHERINAE

Genus HEMICYTHERE Sars, 1925

Hemicythere palosensis LeRoy
Plate 3, figure 10a–b

Hemicythere palosensis LEROY, 1943, Jour. Pal., vol. 17, p. 365, pl. 60, figs. 14–18; text-fig. 2c.

This species, originally described from the Plio-Pleistocene of California, has been found in Trinidad in the Ste. Croix Quarry, in the *Globorotalia fohsi* zone of the Karamat and Brasso formations, and in the Pliocene Talparo formation. Length 0.54 mm.; height 0.29 mm.; width 0.19 mm.

Hemicythere antillea van den Bold
Plate 1, figure 9a–b

Hemicythere antillea VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 101, pl. 5, fig. 8.

This is one of the most common species in both the Morne Diablo and the Ste. Croix Quarries. It occurs also in a sample from the Miocene of the Dominican Republic. *Archicythereis antillea* van den Bold (1946, p. 104, pl. 5, fig. 7) very probably represents instars of this species. Length 0.57 mm.; height 0.37 mm.; width 0.31 mm.

Genus AURILA Pokorný, 1955

Aurila deformis (Reuss)
Plate 1, figure 8

Cypridina deformis REUSS, 1850, Naturw. Abh., vol. 3, pt. 1, p. 29, pl. 9, fig. 25.

Cythere deformis (Reuss). – BOSQUET, 1852, Acad. Roy. Sci. Lett. Belgique, Mém. Cour., vol. 24, p. 82, pl. 4, fig. 4.

?Cythere deformis (Reuss). – HEJJAS, 1892, Erdélyi Muzeum-Egylet, Értesítö, Orvos-Term. Tud., vol. 17, pt. 2, p. 154. – CAPEDER, 1902, R. Accad. Sci. Torino, Atti, vol. 37, p. 10, pl., fig. 14.

Brachycythere deformis (Reuss). – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 107, pl. 13, fig. 2.

Hemicythere deformis (Reuss). – KEY, 1955, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, p. 103, pl. 18, figs. 5–7.

Not *Cythere deformis* BAIRD, 1850, *Natural History of British Entomostraca*, p. 256, pl. 18, figs. 4–6.

The writer has not seen the original material from the Vienna Basin, but Key (1955) compared the writer's Cuban specimens (van den Bold, 1946) with European material. The Trinidad specimens are identical with the Cuban ones and with specimens from the upper Chickasawhay and Alum Bluff formations of Florida. In Trinidad this species has so far been found only in the Ste. Croix and Morne Diablo Quarries. It is also common in a sample from the Miocene of the Dominican Republic. Length 0.72 mm.; height 0.49 mm.

Aurila trigonula (Jones)
Plate 4, figure 8

Cythere trigonula JONES, 1857, *Monograph of the Tertiary Entomostraca*, p. 25, pl. 3, fig. 1a–h. – JONES AND SHERBORN, 1889, *Supplementary monograph of the Tertiary Entomostraca*, p. 19.

?Brachycythere lincolnensis LEROY, 1943, Jour. Pal., vol. 17, p. 364, pl. 61, figs. 1–5; pl. 62, figs. 1–2; text-fig. 21–m.

Hemicythere trigonula (Jones). – KEY, 1955, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, p. 125, pl. 18, figs. 9–10.

Brachycythere trigonalis (Jones) var. *macropunctata* van den Bold (1946, p. 108, pl. 13, fig. 12) and *Brachycythere lincolnensis* LeRoy var. *schumannensis* LeRoy (1943, p. 364, pl. 69, figs. 1–6; text-figs. 1b, 2i–j) appear to be no more than local varieties of this species. The name "*trigonalis*" used by the writer (1946) is an error for "*trigonula*." This species, which was originally described from the Pliocene of England, has been recorded by Key from the Aquitanian and Burdigalian of southwestern France. It is also possibly present in the Plio-Pleistocene of California. In Trinidad it has been found in the Ste. Croix and Morne Diablo Quarries and in the upper part of the Brasso formation (*Globorotalia fohsi* zone). Length 0.52 mm.; height 0.33 mm.

Genus CAUDITES Coryell and Fields, 1937

Caudites medialis Coryell and Fields
Plate 3, figure 6

Caudites medialis CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 11, text-fig. 12a–c.

This species, which was originally described from the Gatun Miocene, has been found only in the Ste. Croix Quarry. Length 0.55 mm.; height 0.27 mm.

Caudites sellardsi (Howe and Neill)
Plate 3, figure 8

Hemicythere sellardsi HOWE AND NEILL, 1935, in HOWE, Florida. Dept. Cons., Geol. Bull. no. 13, p. 29, pl. 2, figs. 6, 10.

Caudites sellardsi (Howe and Neill). – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 103, pl. 14, fig. 2. – PURI, 1953, Washington Acad. Sci., Jour., vol. 43, p. 176, pl. 2, fig. 6; 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 265, pl. 11, fig. 17.

Only two specimens of this species have been found in the Ste. Croix Quarry. It occurs also in the higher parts of the Brasso formation. In the Pliocene it is replaced by the related species *Caudites nipeensis* van den Bold, which also occurs in the Gulf of Paria. Length 0.47 mm.; height 0.22 mm.

Caudites fragilis LeRoy
Plate 3, figure 7

Caudites fragilis LEROY, 1943, Jour. Pal., vol. 17, p. 372, pl. 60, figs. 10–13; text-fig. 2r–s.

This species, which was originally described from the Plio-Pleistocene of California, occurs in the Ste. Croix Quarry and in the Los Atajos, Upper Miocene. Length 0.55 mm.; height 0.26 mm.

Genus HERMANITES Puri, 1955

Hermanites haidingeri (Reuss)
Plate 2, figure 1a–b

Cypridina haidingeri REUSS, 1850, Naturw. Abh., vol. 3, p. 78, pl. 10, fig. 13a–b.

?Cythere haidingeri (Reuss). – BOSQUET, 1852, Acad. Roy. Sci. Lett. Belgique, Mém. Cour., vol. 4, p. 125, pl. 6, fig. 10a–e. – SEGUENZA, 1884, Naturalista Siciliano, vol. 3, p. 263.

Cythereis laticarinata LIENENKLAUS, 1900, Deutsch. Geol. Ges., Zeitschr., vol. 52, p. 125, pl. 6, fig. 10.

Cythereis trigibbosa NEVIANI, 1928, Accad. Pont. Sci. Nuovi Lincei, Mem., ser. 2, vol. 11, p. 72, pl. 1, figs. 48–50.

?Cythereis sp. 19, HOWE, 1934, Guidebook 11th Ann. Field Trip Shreveport Geol. Soc., pl. 1, figs. 19–21.

Cythereis tschoppi VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 93, pl. 10, fig. 14a–b; 1950, Jour. Pal., vol. 24, p. 83.

Cythereis macropora (Bosquet). – Ruggieri, 1952, Bologna, Univ., Ist. Zool., Lab. Biol. Mar. Fano, Note, vol. 1, p. 126.

?Hermanina reticulata Puri, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 267, pl. 11, figs. 8–9; text-fig. 9g–h.

Cythereis haidingeri (Reuss). – Ruggieri, 1953, Giorn. Geol., ser. 2, vol. 23, p. 76, pl. 2, fig. 12a–c.

?Hermanites reticulata (Puri). – Puri, 1955, Jour. Pal., vol. 29, p. 558.

Trachyleberis haidingeri (Reuss). – Key, 1955, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, p. 126, pl. 17, fig. 7; pl. 20, fig. 2.

The holotype of *Cythereis tschoppi* van den Bold has been compared with the one specimen from Trinidad and with specimens in the writer's collection from the upper Chickasawhay, Red Bluff, and Chipola formations. It was also found to be identical with specimens from the Aquitaine Basin in France, which had been compared by Key (1955) with material from the Vienna Basin. There appears to be no doubt that *Cythereis tschoppi* van den Bold is identical with *Cypridina haidingeri* Reuss. The writer has not seen the types of *Hermania reticulata* Puri, so that their identification with *Cypridina haidingeri* is not absolutely certain.

The range of *Hermanites haidingeri* (Reuss) in Europe, according to the published literature, is from the Lower Eocene to the Quaternary, but Key (oral communication) has informed the writer that he does not consider Bosquet's specimens from the Ypresian of France exactly identical with Reuss' species. In the Gulf Coast the range of *Hermanites haidingeri* appears to be from the Lower Oligocene (Red Bluff) to the Middle Miocene (Alum Bluff), according to the writer's own observations. In Cuba the writer has found the species in beds ranging in age from Upper Eocene to Middle Miocene (Guines formation).

Dimensions of the Trinidad specimen: Length 0.61 mm.; height 0.40 mm.

Hermanites hutchisoni van den Bold, **new species**
Plate 3, figure 1a–b

Carapace small, rectangular, highest near the anterior end. Anterior end obliquely rounded, with a broad, flattened rim, denticulate; dorsal and ventral margins slightly concave and subparallel; posterior end short, concave above, truncate below, bearing five or six short spines. Subcentral tubercle strongly elevated, in dorsal view with concave posterior side. Strong ventral and dorsal ridges, the ventral one ending slightly more anteriorly than the dorsal one. The latter obscures part of the dorsal margin. In dorsal view the greatest width is at the end of the ventral ridge; the subcentral tubercle is nearly as strongly projecting. Length 0.40 mm.; height 0.21 mm.; width 0.21 mm.

Cythereis thoracophora van den Bold (1946, p. 92, pl. 10, fig. 25) is very similar in shape and size, but in dorsal view the two ventral ridges are nearly parallel, and the greatest width is at the subcentral tubercle. The same is true of *Cythere anna* Lienenklaus (1894, p. 209, pl. 14, fig. 10a–c).

This species has been named in honour of Dr. A. G. Hutchison, former chief geologist of United British Oilfields of Trinidad. It is abundant in the Ste. Croix Quarry, but has not been found elsewhere in Trindad, although a closely related form was observed in a few samples from Recent deposits in the Gulf of Paria. This is probably the form described by Key (1954, p. 223, pl. 4, fig. 12a–b) as *Trachyleberis* cf. *thoracophora* (van den Bold).

Holotype: A complete carapace from the Ste. Croix Quarry; U. S. Nat. Mus. no. 562050.

Hermanites? pannosa (Brady)
Plate 2, figure 2

Cythere pannosa Brady, 1869, *Les fonds de la mer*, vol. 1, p. 154, pl. 19, figs. 1–2.

Cythereis vicksburgensis Howe, 1936, in Howe and Law, Louisiana, Dept. Cons., Geol. Bull. no. 7, p. 34, pl. 4, fig. 4; pl. 5, figs. 1–2. – van den Bold, 1946, *Contribution to the study of Ostracoda*, p. 69, pl. 10, fig. 5; 1950, Jour. Pal., vol. 24, p. 82.

?Cythereis bicarinata Swain, 1946, Jour. Pal., vol. 20, p. 376, pl. 54, fig. 7a–d; pl. 55, fig. 1a–e.

This species occurs in the Ste. Croix, Mejias, Morne Diablo, Quinam and Kapur Quarries. It ranges in Trinidad from Upper Eocene to Recent, and the same range has been found in Cuba (van den Bold, 1946). In the Gulf Coast the writer has found the same species in the Upper Eocene Cooper marl and in the upper Chickasawhay (Lower Miocene). It is believed that Swain's species from the Ocala limestone is identical with *Cythereis vicksburgensis* Howe. *Cythere pannosa* Brady, which was described from Colon-Aspinwall, is believed to be the oldest name for this species. Length 0.67 mm.; height 0.39 mm.

Hermanites kewi (LeRoy)

Cythereis kewi LeRoy, 1943, Jour. Pal., vol. 17, p. 369, pl. 60, figs. 24–27; pl. 62, figs. 9–10; text-fig. 2d.

Trachyleberis kewi (LeRoy). – Crouch, 1949, Jour. Pal., vol. 23, p. 597.

The specimens from the Morne Diablo Quarry differ very slightly from those of the California Plio–Pleistocene. In the first place, the ventral ridge appears to end at a greater distance in front of the end of the dorsal ridge than it does in LeRoy's side-view figure. However, in his dorsal-view figure, the distance is more in accordance with that in the Trinidad specimens. In the second place, in the dorsal view of the female the subcentral tubercle appears to project beyond the ventral ridge more than it does in LeRoy's figure; the dorsal views of the male specimens, on the other hand, are identical. Moreover, the Trinidad specimens are slightly smaller than the California ones. These differences are thought to be insufficient to separate the Trinidad specimens from *Cythereis kewi* LeRoy.

Dimensions:	Length	Height	Width
Female(?):	0.57 mm.	0.32 mm.	0.25 mm.
Male(?):	0.60 mm.	0.30 mm.	0.21 mm.

This species has been found only in the Morne Diablo Quarry.

Genus BRADLEYA Hornibrook, 1952

Bradleya dictyon (Brady)

Cythere dictyon BRADY, 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 99, pl. 24, fig. 1a–v.

?Cythere dictyon Brady. – GUPPY, 1893, Trinidad Field Nat. Club, Jour., vol. 1, p. 28.

Bradleya dictyon (Brady). – HORNIBROOK, 1952, New Zealand, Geol. Survey, Pal. Bull. no. 18, p. 39, pl. 6, figs. 81–82, 84–85 (with extensive synonymy).

Trachyleberis dictyon (Brady). – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 222, pl. 4, fig. 9.

This species appears to have a world-wide range from Oligocene to Recent, which coincides exactly with the observed range in Trinidad, where it has been found ranging from the *Globigerina ciperoensis* zone upward. It occurs in the Ste. Croix, Morne Diablo and Mejias Quarries. Length 0.73 mm.; height 0.42 mm.; width 0.41 mm.

Bradleya sp.
Plate 2, figure 3a–b

Carapace elongate subrectangular, highest near the anterior end. Anterior end obliquely rounded; dorsal and ventral margins nearly straight and converging slightly posteriorly; posterior end angled in the middle, straight above, convex and denticulate below. Ornamentation consists of a reticulate pattern in which a dorsal ridge, a ventral ridge, and a strong median ridge stand out. The median ridge converges toward the dorsal one at its posterior end; in the middle of the carapace it splits, and the lower branch forms a very characteristic loop before continuing parallel to the original median ridge. Length 0.65 mm.; height 0.35 mm.; width 0.33 mm.

Only three specimens of this species have been found in the Ste. Croix Quarry, which is considered to be insufficient material for the establishment of a new species.

Subfamily TRACHYLEBERIDINAE

Genus TRACHYLEBERIS Brady, 1898

Trachyleberis reticulospinosa (van den Bold)
Plate 1, figure 10

Cythereis reticulospinosa VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 100, pl. 6, fig. 18.

This species was originally described from the Upper Eocene of Bonaire. In Trinidad it has been found in deposits ranging in age from Middle Eocene to Lower Miocene. It is fairly common in the Ste. Croix Quarry and occurs also in the Navet, San Fernando, and Brasso formations; the highest occurrence known so far is in the *Globorotalia fohsi* zone. Length 0.85 mm.; height 0.50 mm.

Trachyleberis? hazelae (van den Bold)
Plate 1, figure 11

Cythereis hazeli VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 92, pl. 10, fig. 4.

The writer has endeavoured to give a more detailed drawing of this large and heavily ornamented species. The oldest occurrence is in the Upper Eocene. It has also been found in the lower and upper Cipero (e.g., type locality for the *Globorotalia fohsi robusta* zone) and in the Lengua formation. One specimen has been found in the Ste. Croix Quarry and one in the contemporaneous Trinidad Point calcareous clay (see Cushman and Renz, 1947). Length 1.29 mm.; height 0.74 mm.

Genus **Costa** Neviani, 1928

Genotype: Cytherina edwardsi Roemer, 1838.

A genus of the Trachyleberidinae with the following characteristics: Carapace reticulate with anterior rim and three longitudinal ridges. Posterior end compressed, triangular in side view, denticulate below. Interior similar to *Rectotrachyleberis*.

It is very difficult to distinguish at present between *Costa* Neviani, *Rectotrachyleberis* Ruggieri and *Trachyleberidea* Bowen, as differentiation seems possible only on the basis of the ornamentation. Until definite characteristics of undoubtedly generic value can be indicated, the writer proposes to use the genus *Costa* for all three-ribbed species of the Trachyleberidinae.

Costa variabilocostata (van den Bold)
Plate 2, figure 4

Cythereis variabilocostata VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 83, pl. 18, fig. 3a–b.

This is one of the most common Ostracoda in Trinidad. It occurs throughout the Brasso formation and in the Cipero, Talparo, and Springvale formations, and it is very common in the seas around Trinidad. Of the many species described by Brady from the Caribbean area in "Les fonds de la mer" and the Challenger Report, none could be identified with this one. The species is apparently related to *Cytherina edwardsi* Roemer (1838); for modern figures see Ruggieri (1950, text-fig. 4) and Key (1955, pl. 16, fig. 8). It has been found in the Ste. Croix, Morne Diablo and Kapur Quarries. Length 0.68 mm.; height 0.37 mm.

Costa santacrucensis van den Bold, **new species**
Plate 2, figure 5a–b

Carapace ovate in the female, elongate ovate in the male. Anterior end regularly rounded, with narrow rim, denticulate; dorsal and ventral margins slightly convex,

converging very gently posteriorly in the female, more strongly so in the male; posterior end angled just below the middle, nearly straight above, rounded and bearing three or four spines below. Left valve overlapping the right at the dorsal side of the posterior end and very slightly at the anterodorsal margin. Ornamentation consists of a reticulate pattern in which three or four longitudinal ridges stand out; the dorsal ridge, obscuring the dorsal margin in side view, is slightly lobate, the four to five lobes corresponding to reticulations; the ventral ridge, sometimes rather obscure, is the continuation of the anterior rim; two median ridges, which in most of the specimens join together in the posterior portion of the carapace, are separate in the middle and become obscure and subparallel toward the anterior end.

In many specimens the usually rather coarse reticulation rapidly becomes obscure away from the longitudinal ridges. The hinge is of the usual trachyleberidine type, and none of the elements shows any sign of crenulation. Marginal area moderately broad; line of concrescence and inner margin coincide; pore canals numerous.

Dimensions:	Length	Height
Female:	0.73 mm.	0.42 mm.
Male:	0.78 mm.	0.42 mm.

This species occurs in the Ste. Croix and Morne Diablo Quarries and throughout the greater part of the Brasso formation. Its oldest recorded occurrence is in the *Globigerinatella insueta* zone, its youngest in the *Globorotalia fohsi lobata* zone.

A few specimens have been found in Recent mud from the Gulf of Paria; they were thought to be reworked. However, in view of the fact that this species looks very similar in outline to *Trachyleberis* sp. (Key, 1954, p. 223, pl. 5, fig. 1a–b) from the Bocas del Dragon, it is quite possible that they are the same species, which is still living off the coast of Trinidad. It is peculiar, however, that we have not encountered this species in any samples younger than the *Globorotalia fohsi* zone.

Holotype: A complete carapace from the Tunnel Hill member of the Brasso formation (*Globorotalia fohsi lobata* zone) of K. Rohr's Tabaquite auger line (R. 12305); U. S. Nat. Mus. no. 562052.

Costa macerta (Stephenson)

Cythereis macerta Stephenson, 1944, Jour. Pal., vol. 18, p. 157, pl. 28, figs. 6–7.

This species has been found only in the Ste. Croix Quarry. In the Pliocene it is replaced by the closely related form *Cythere lauta* Brady (1880, p. 85, pl. 21, fig. 4a–d), which is relatively shorter and thicker and more strongly reticulate. The related form *Cythereis triplistriata* Edwards has been referred by Puri (1953*b*, p. 264) to the genus *Rectotrachyleberis* Ruggieri, and another related form, *Cythereis guinesensis* van den Bold, has been referred to *Caudites* Coryell and Fields by Key (1955, p. 131). The generic position of this group of species remains doubtful. Length 0.55 mm.; height 0.22 mm.; width 0.20 mm.

Genus Orionina Puri, 1953

Orionina bermudae (Brady)

Plate 1, figure 12a–b

Cythere serrulata Brady, 1868, *Les fonds de la mer*, vol. 1, p. 153, pl. 18, figs. 11–12 (not *Cythere serrulata* Bosquet, 1852).

Cythere bermudae Brady, 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 90, pl. 21, fig. 2a–d.

Cythere vaughani Ulrich and Bassler, 1904, Maryland, Geol. Survey, Miocene, p. 109, pl. 38, fig. 25.

Cythere ramdohri Müller, 1912, *Das Tierreich*, p. 358.

Cythereis vaughani (Ulrich and Bassler). – Howe, 1935, Florida, Dept. Cons., Geol. Bull. no. 13, p. 25, pl. 3, figs. 24–26; pl. 4, fig. 13. – Coryell and Fields, 1937, Amer. Mus. Novitates, no. 956, p. 9, text-fig. 10. – Edwards, 1944, Jour. Pal., vol. 18, p. 522, pl. 85, figs. 27–28. – van den Bold, 1946, *Contribution to the study of Ostracoda*, p. 88, pl. 10, fig. 1; 1950, Jour. Pal., vol. 24, p. 83.

Trachyleberis vaughani (Ulrich and Bassler). – Swain, 1952, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 37, pl. 6, figs. 6–7. – Malkin, 1953, Jour. Pal., vol. 27, p. 794, pl. 82, fig. 14.

Orionina vaughani (Ulrich and Bassler). – Puri, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 254, pl. 12, figs. 15–16; text-fig. 8a–c.

The writer has not been able to find any difference between the specimens from the *Globigerinatella insueta* zone, the oldest occurrence in Trinidad, and those from Recent deposits in the Gulf of Paria. The marginal area could be studied very well, especially in the Pliocene specimens, and was found to differ from Puri's description. The marginal area shows indentations of the line of concrescence from which radial pore canals are seen branching off in much the same way, though on a somewhat smaller scale, as in *Leptocythere*. This was also pointed out to the writer by Dr. E. Triebel (letter dated Feb. 28, 1955). The generic description of *Orionina* should be emended in this way.

Dimensions:	Length	Height
Male:	0.70 mm.	0.36 mm.
Female:	0.66 mm.	0.35 mm.

This species occurs regularly throughout the Trinidad Miocene. In Colombia the writer found it in beds correlated on the basis of larger foraminifera with the Heterostegina zone of the Gulf Coast. In the Gulf Coast area it appears to occur from the Alum Bluff formation upward.

Genus Echinocythereis Puri, 1953

Echinocythereis asperrima (Reuss)

Cypridina asperrima Reuss, 1850, Naturw. Abh., vol. 3, pt. 1, p. 74, pl. 10, fig. 5.

Cypridina echinata Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., vol. 3, p. 90, pl. 7, fig. 66.

Cythere lyelliana Bosquet, 1852, Acad. Roy. Sci. Lett. Belgique, Mém. Cour., vol. 24, p. 102, pl. 5, fig. 6.

?Cypridina hirta Costa, 1859, *Paleontologia del Regno di Napoli; Parte III*, p. 174, pl. 15, fig. 2a–c.

Cythere erinaceus Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., vol. 7, p. 367, pl. 21, fig. 7.

?Cythere asperrima (Reuss). – Seguenza, 1880, R. Accad. Lincei Roma, Cl. Sci. Fis. Mat. Nat., Mem., ser. 3, vol. 6, pp. 124, 324.

Cythere asperrima (Reuss). – Lienenklaus, 1894, Deutsch. Geol. Ges., Zeitschr., vol. 46, p. 195; 1900, ibid., vol. 52, p. 516.

Cythereis sarsi Müller, 1894, *Die Ostracoden des Golfes von Neapel*, p. 370, pl. 8, fig. 8. – Rome, 1942, Monaco, Inst. Oceanogr., Bull., no. 819, p. 352.

?Cythere spinosissima Brady. – Capeder, 1900, R. Accad. Sci. Torino, Atti, vol. 35, p. 11, pl. 1, fig. 21a–b.

?Cythere dasyderma circumdentata Brady. – Namias, 1901, Palaeontogr. Ital., vol. 6, p. 24, pl. 6, fig. 11.

?Cythere cribriformis Brady. – Capeder, 1902, R. Accad. Sci. Torino, Atti, vol. 37, p. 10, pl., fig. 13a–b.

Cythere evax Ulrich and Bassler, 1904, Maryland, Geol. Survey, Miocene, p. 119, pl. 36, figs. 6–8.

Cythere evax var. *oblongata* Ulrich and Bassler, 1904, ibid., p. 119, pl. 36, figs. 9–10.

Cythere scabra (Reuss). – Neviani, 1906, Soc. Geol. Ital., Boll., vol. 25, p. 189, text-fig. 5.

Cythereis asperrima (Reuss). – Kähn, 1917, Naturh. Ges. Colmar, Mitt., new ser., vol. 14, p. 72, pl. 12, fig. 15. – Kuiper, 1918, *Oligocäne und Miocäne Ostracoden aus den Niederlanden*, p. 43, pl. 2, fig. 15. – Ruggieri, 1952, Giorn. Geol., ser. 2, vol. 22, p. 97; 1953, ibid., ser. 2, vol. 23, p. 74.

Cythereis hystrix (Reuss). – Kuiper, 1918, *Oligocäne und Miocäne Ostracoden aus den Niederlanden*, p. 53, pl. 2, fig. 21a–b.

?Cythereis asperrima (Reuss). – Mehes, 1941, Geol. Hungarica, Ser. Pal., fasc. 16, p. 46, pl. 5, figs. 15–16; text-figs. 2(36), 3(76), 4(124–125).

Cythereis evax (Ulrich and Bassler). – van den Bold, 1946, *Contribution to the study of Ostracoda*, p. 90, pl. 10, fig. 19.

Cythereis evax et var. *oblongula* (Ulrich and Bassler). – Swain, 1948, Maryland, Dept. Geol., Mines and Water Resources, Bull., no. 2, p. 204, pl. 12, figs. 19–20.

Trachyleberis evax (Ulrich and Bassler). – Swain, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 28, pl. 3, figs. 1–3. – Malkin, 1953, Jour. Pal., vol. 27, p. 792, pl. 82, figs. 4–5.

Cythereis aff. *dasyderma* (Brady). – Ruggieri, 1949, Giorn. Geol., ser. 2, vol. 20, p. 28.

Cythereis hirta (Costa). – Ruggieri, 1950, Giorn. Geol., ser. 2, vol. 21, p. 25; 1952, Bologna, Univ., Ist. Zool., Lab. Biol. Mar. Fano, Note, vol. 1, no. 8, p.62.

Echinocythereis evax (Ulrich and Bassler). – Puri, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 260, pl. 12, fig. 1; text-fig. 9c.

Howella evax (Ulrich and Bassler). – Puri, 1956, Jour. Pal., vol. 30, p. 275, pl. 35, figs. 1–8.

?Howella echinata Puri, 1956, Jour. Pal., vol. 30, p. 275, pl. 35, figs. 9–14; pl. 36, figs. 1–4.

The writer has compared his material with specimens from the Maryland Miocene and from the Upper Eocene Cooper marl (van den Bold, 1950*b*, p. 107), and with specimens from the Rupelian of Belgium and from the Oligo-Miocene of the Netherlands that had been compared by Key (publication in press) with material from the Rupelian of Hermsdorf and from the Tortonian of Austria, from which Reuss' original material came. The writer prefers, for the time being, to leave this species in the genus *Echinocythereis* because the differences between this genus and *Howella* do not appear to be important enough to warrant separation.

In Trinidad the range of the species is Upper Eocene to Pliocene; in Cuba, Upper Eocene to Middle Oligocene; in the Gulf Coast, Upper Eocene (?) and Middle Miocene; and in Europe, Lower Oligocene to Recent. In the present material the species was found in the Quinam and Kapur Quarries. Length 0.88 mm.; height 0.53 mm.

Echinocythereis garretti (Howe and McGuirt)

?Cythere circumdentata Brady. – Guppy, 1893, Trinidad Field Nat. Club, Jour., vol. 1, p. 28.

Cythereis garretti Howe and McGuirt, 1935, in Howe, Florida, Dept. Cons., Geol. Bull. no. 13, p. 20, pl. 3, figs. 17–19; pl. 4, figs. 5, 15.

Buntonia? cf. *garretti* (Howe and McGuirt). – Swain, 1951, U.S. Geol. Survey, Prof. Paper no. 234–A, p. 39, pl. 3, fig. 6; pl. 4, figs. 4–6.

Echinocythereis garretti (Howe and McGuirt). – Puri, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 260, pl. 12, figs. 2–5; text-fig. 9a–b.

This species occurs in Trinidad from the *Globigerinatella insueta* zone upward. It has been found in the Ste. Croix Quarry, the Cipero formation, and the Lengua and Cruse formations. Length 0.82 mm.; height 0.52 mm.

Genus Cativella Coryell and Fields, 1937

Cativella sp. cf. **Cativella semitranslucens** (Crouch)
Plate 2, figure 6

?Trachyleberis semitranslucens Crouch, 1949, Jour. Pal., vol. 23, p. 597, pl. 96, fig. 1.

?Bradleya sp., Key, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 223, pl. 4, fig. 13a–c; pl. 6, fig. 10.

Only one specimen has been found in the present material, in the Quinam Quarry, and its preservation does not permit an accurate determination. Length 0.64 mm.; height 0.33 mm.

There are three distinct forms in Trinidad, all of which may belong to *Cativella navis* Coryell and Fields (1937, p. 9, text-fig. 9):

1) With anterior keel separated from the dorsal keel. This form may be identical with *Cativella semitranslucens* (Crouch). It occurs in the Gulf of Paria,

throughout the Brasso formation (*Globigerinatella insueta* zone to *Globorotalia fohsi lobata* zone), and in the Upper Eocene San Fernando formation. The specimen from the Quinam Quarry may belong to this form.

2) With anterior keel continuous into the dorsal one; a large form with thin keels and long spines. This form occurs also in the Gulf of Paria, although not as regularly as the preceding one. It appears to be identical with the types of *Cativella navis* from the Gatun formation of Panama. *Cativella* sp. of Triebel (1941, pl. 11, fig. 128), from the Caribbean, may be the same form.

3) With anterior keel continuous into the dorsal one; a small form with thick keels or rows of spines. This is the form described by van den Bold (1946, p. 104, pl. 12, fig. 11; 1950*b*) and by Puri (1953*b*, p. 262, pl. 11, figs. 3–7, text-fig. 9i–k) from the Miocene of Guatemala, Venezuela and Florida. In Trinidad it has been found in the upper part of the Brasso formation (Navarro River member), in the Cruse, Forest and Springvale formations, and in the Melajo beds. The difference between this form and Form 2 may be only a question of facies or preservation.

Genus PURIANA Coryell and Fields, 1953

Puriana sp. aff. **Puriana puella** (Coryell and Fields)
Plate 3, figure 9a–b

Favella puella CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 8, text-fig. 8a–c.

Cythereis rugipunctata (Ulrich and Bassler) var. *gatunensis* CORYELL AND FIELDS, 1937, ibid., p. 10, text-fig. 11.

Puriana puella (Coryell and Fields). – PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 257, pl. 12, fig. 17.

The Trinidad specimens differ from *Cythere rugipunctata* Ulrich and Bassler (1904, p. 118, pl. 38, figs. 16–17) in having the posterodorsal portion of the carapace smoother. Unfortunately, no figures of *Puriana puella* that permit detailed comparison have been published. The writer has compared some of his specimens with Coryell and Fields' types in the American Museum of Natural History in New York, and has found them to be very similar but not quite identical.

This species has been found only in the Ste. Croix, Morne Diablo and Quinam Quarries. In the younger Miocene it is replaced by the larger and more rugose *Puriana rugipunctata* (Ulrich and Bassler). In the Morne Diablo a few specimens have been found of still another species of *Puriana*, but the preservation is so poor that they do not merit a description. Length 0.52 mm.; height 0.27 mm.

Genus BASSLERITES Howe, 1937

Basslerites berchoni (Brady)

Cythere berchoni BRADY, 1870, *Les fonds de la mer*, vol. 1, p. 117, pl. 14, figs. 3–4. – MÜLLER, 1912, *Das Tierreich*, p. 371.

?Cythere berchoni Brady. – CARUS, 1885, *Prodromus faunae Mediterraneae*, p. 300 (not seen).

Cythereis teres Brady. – MÜLLER, 1894, *Die Ostracoden des Golfes von Neapel*, p. 379, pl. 29, figs. 6, 15; 1912, *Das Tierreich*, p. 388 (part).

Not *Cythere teres* BRADY, 1870, *Les fonds de la mer*, vol. 1, p. 147, pl. 14, figs. 17–18.

Basslerella miocenica HOWE, 1935, Florida, Dept. Cons., Geol. Bull. no. 13, p. 30, pl. 1, figs. 19, 24–26.

Basslerites miocenicus (Howe). – CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 12, text-fig. 13a–b. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 106 (part); 1950, Jour. Pal., vol. 24, p. 85. – PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 280, pl. 8, figs. 10–11; text-fig. 11k.

Basslerites teres (Brady). – RUGGIERI, 1950, Giorn. Geol., ser. 2, vol. 21, p. 42, text-fig. 26. – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 224, pl. 5, fig. 2a–b.

Basslerites cf. *miocenicus* (Howe). – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 47, pl. 7, figs. 5–6.

Basslerites berchoni (Brady). – RUGGIERI, 1953, Giorn. Geol., ser. 2, vol. 23, p. 169.

The range of this species in Trinidad appears to be from the *Globorotalia fohsi* zone up to the Recent. The writer has not been able to distinguish the Recent from the fossil forms. Length 0.45 mm.; height 0.25 mm.

Subfamily LOXOCONCHINAE

Genus LOXOCONCHA Sars, 1866

Loxoconcha fischeri (Brady)
Plate 2, figure 7

Cythere fischeri BRADY, 1869, *Les fonds de la mer*, vol. 1, p. 154, pl. 18, figs. 15–16. – MÜLLER, 1912, *Das Tierreich*, p. 374.

Loxoconcha antillea VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 110, pl. 18, fig. 3; 1950, Jour. Pal., vol. 24, p. 86.

Loxoconcha fischeri (Brady). – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 225, pl. 5, fig. 3.

This species occurs in the seas around Trinidad and has also been found in the Ste. Croix and Morne Diablo Quarries. In Cuba, Guatemala and Venezuela, the species is reported from the Miocene. In the Antigua limestone (*Globigerina ciperoensis* zone), a very similar (possibly the same) species occurs. Length 0.57 mm.; height 0.29 mm.

Loxoconcha rugosa van den Bold

Loxoconcha sp., TRIEBEL, 1941, Senckenbergiana, vol. 23, pl. 11, fig. 127.

Loxoconcha antillea var. *rugosa* VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 110, pl. 15, fig. 6.

?Loxoconcha alata Brady var. *longispina* KEY, 1953, K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 56, no. 2, p. 160, pl. 1, fig. 10a–b.

This species accompanies *Loxoconcha fischeri* both in the Recent deposits and in the Morne Diablo Quarry. Length 0.54 mm.; height 0.31 mm.; width 0.35 mm.

Loxoconcha banesensis van den Bold
Plate 4, figure 13

Loxoconcha banesensis VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 112, pl. 15, fig. 11.

A few specimens of this species have been found in the Ste. Croix Quarry. It occurs also in the Brasso and Talparo formations. Length 0.35 mm.; height 0.22 mm.

Subfamily CYTHERURINAE

Genus CYTHERURA Sars, 1866

Cytherura hermesi van den Bold
Plate 4, figure 10a–b

Cytherura hermesi VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 117, pl. 14, fig. 15.

This species from the Cuban Miocene has been found in Trinidad in Upper Eocene, Oligocene and Miocene deposits. It occurs in the Ste. Croix Quarry. Length 0.45 mm.; height 0.22 mm.; width 0.21 mm.

Cytherura sp.
Plate 4, figure 11

Two specimens of a species of *Cytherura* have been found in the Morne Diablo Quarry. Carapace elongate, subquadrate. Anterior end obliquely rounded, dorsal and ventral margin nearly straight and parallel, posterior end produced above the middle. Surface ornamented with longitudinal low ridges and a deep ovate depression in the posteroventral portion. Length 0.38 mm.; height 0.19 mm.

Genus EUCYTHERURA Müller, 1894

Eucytherura complexa (Brady)
Plate 4, figure 14

Cythere complexa BRADY, 1866, Zool. Soc. London, Trans., vol. 5, p. 210 (not seen).

Cythere limicola Norman. – BRADY, 1868, Linn. Soc. London, Trans., vol. 26, pt. 2, p. 405, pl. 31, figs. 38–41 (part).

Cythere complexa Brady. – BRADY AND NORMAN, 1889, Roy. Dublin Soc., Sci. Trans., ser. 2, vol. 4, p. 145, pl. 19, figs. 31–32.

Eucytherura dilatata MÜLLER, 1894, *Die Ostracoden des Golfes von Neapel*, p. 306, pl. 20, figs. 13, 17; pl. 21, fig. 3.

Eucytherura complexa (Brady). – MÜLLER, 1912, *Das Tierreich*, p. 280. – WEINGEIST, 1949, Jour. Pal., vol. 23, pl. 73, fig. 15.

Not *Eucytherura complexa* (Brady). – MEHES, 1941, Geol. Hungarica, Ser. Pal., fasc. 16, p. 61, pl. 2, figs. 1–2; text-figs. 1 (14), 2 (46), 3 (83).

Eucytherura aff. *complexa* (Brady). – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 228, pl. 5, figs. 13–14.

This species has been found in the Morne Diablo Quarry and in the Forest and Talparo formations. It occurs fairly regularly in the Gulf of Paria. Length 0.28 mm.; height 0.17 mm.; width 0.19 mm.

Eucytherura sp. cf. **Eucytherura gullentopsi** Ruggieri
Plate 4, figure 15

Eucytherura gullentopsi RUGGIERI, 1952, Giorn. Geol., ser. 2, vol. 22, pp. 30–31, pl. 7, figs. 2–4.

Only two specimens have been found in the Morne Diablo Quarry. They resemble Ruggieri's figures in the shape of the ventral ridge and the ornamentation, but are much shorter. Length 0.35 mm.; height 0.19 mm.; width 0.17 mm.

Genus HEMICYTHERURA Elofson, 1941

Hemicytherura videns (Müller)
Plate 4, figure 12

Cytheropteron videns MÜLLER, 1894, *Die Ostracoden des Golfes von Neapel*, p. 303, pl. 20, figs. 2, 8; 1912, *Das Tierreich*, p. 227. – ROME, 1942, Monaco, Inst. Oceanogr., Bull., no. 768, p. 13.

Cytheropteron (Hemicytherura) videns (Müller). – KLIE, 1942, Zool. Anz., vol. 138, p. 72.

Cytherura cf. *scutellata* (Brady). – KINGMA, 1948, *Contribution to the knowledge of the Young Caenozoic Ostracoda*, p. 97, pl. 11, fig. 18.

Cytherura (Hemicytherura) cellulosa (Norman). – RUGGIERI, 1952, Giorn. Geol., ser. 2, vol. 22, p. 85, pl. 7, fig. 1.

Hemicytherura videns (Müller). – RUGGIERI, 1953, Soc. Ital. Sci. Nat., Atti, vol. 92, p. 49, text-figs. 4, 4a–b, 6, 6a, 9. – KEY, 1955, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, p. 133, pl. 20, fig. 10.

A comparison of the figures given by the various authors shows that the secondary ribs in the ornamentation of this species are quite variable. It is therefore possible that the specimens referred to *Cytherura clathrata* Sars from the Miocene of Cuba (van den Bold, 1946, p. 118, pl. 14, figs. 9–10) belong to *Hemicytherura videns*. In Trinidad it has been found very rarely in the Ste. Croix and Morne Diablo Quarries; it occurs also in the upper part of the Brasso formation, in the "Brasso facies" equivalent of the Lengua formation, and in the Forest formation. It has also been found in the Gulf of Paria. Length 0.30 mm.; height 0.17 mm.

Genus PARACYTHERIDEA Müller, 1894

Paracytheridea tschoppi van den Bold
Plate 4, figure 7

Paracytheridea tschoppi VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 85, pl. 16, figs. 6–7. – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser, 1, vol. 20, p. 220, pl. 4, fig. 4.

This species has been found in the Ste. Croix Quarry, in the upper part of the Brasso formation, and in the Forest formation. Key recorded it from the seas around Trinidad. Length 0.56 mm.; height 0.26 mm.

Genus CYTHEROPTERON Sars, 1866

Cytheropteron leonensis Puri
Plate 4, figure 4a–b

Cytheropteron leonensis PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 242, pl. 4, figs. 11–12; text-fig. 6c–d.

Puri's text-figure 6d is exactly like the Trinidad specimens. His text-figure 6c (dorsal view) appears to be more angular. In most of the Trinidad specimens, the ventral striae mentioned by Puri are not visible because of the state of preservation. They have been observed in some specimens, however, and agree with Puri's description.

The species has been found in the Morne Diablo Quarry. It occurs also in the upper part of the Brasso formation. Length 0.43 mm.; height 0.25 mm.; width 0.25 mm.

Cytheropteron renzi van den Bold, **new species**
Plate 4, figure 5a–b

Carapace ovate, alate, highest slightly behind the middle, widest in the middle. Dorsal margin arched; posterior end produced above the middle, forming a caudal process; anterior end obliquely rounded; ventral margin sinuate. Left valve overlapping the right at the anterodorsal margin. Surface of the valves striated, with rows of small pits which, in the middle and posterior portions of the carapace, are arranged in slightly curved, subvertical rows as in *Cytheropteron lisbonense* Martin (1939, pl. 22, figs. 1–3). Alae bearing a smooth, slightly thickened rim with a tendency toward giving off side-ridges, the most prominent of which encircles a fairly deep pit in the middle of the valve. Dorsal view arrow-shaped, greatest width in the middle, in front of the ends of the alae; posterior end compressed. Length 0.41 mm.; height 0.25 mm.; width 0.22 mm.

The species is fairly long-ranging. A few doubtful occurrences have been noticed in the Oligocene Nariva formation. It occurs in the lower part of the Brasso formation and in the Ste. Croix Quarry, in the "Brasso facies" of the Lengua formation, and in the Forest formation. It has been named in honour of Dr. H. H. Renz, former paleontologist of Trinidad Leaseholds Ltd.

Holotype: A complete carapace from the Ste. Croix Quarry; U. S. Nat. Mus. no. 562051.

Subfamily PARADOXOSTOMINAE

Genus PELLUCISTOMA Coryell and Fields, 1937

Pellucistoma magniventra Edwards

Pellucistoma magniventra EDWARDS, 1944, Jour. Pal., vol. 18, p. 528, pl. 88, figs. 33–35. – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 86. – PURI, 1953, Florida, Geol. Survey, Geol. Bull. no. 36, p. 289, pl. 15, fig. 4; text-fig. 12a.

Pellucistoma cf. *magniventra* Edwards. – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 52.

In Trinidad this species has been found only in the Quinam Quarry (Hg. 112). Length 0.60 mm.; height 0.33 mm.

Pellucistoma kendengensis (Kingma)
Plate 4, figure 9

Javanella kendengensis KINGMA, 1948, *Contribution to the knowledge of the Young Caenozoic Ostracoda*, p. 89, pl. 10, fig. 6.

Pellucistoma kendengensis (Kingma). – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 86, pl. 18, fig. 6; text-fig. 3.

Paradoxostoma sp., KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 362, pl. 3, fig. 9.

This species has been found in the Ste. Croix and Morne Diablo Quarries. Length 0.47 mm.; height 0.24 mm.

Subfamily BYTHOCYTHERINAE

Genus BYTHOCERATINA Hornibrook, 1952

Bythoceratina sp. aff. **Bythoceratina scaberrima** (Brady)
Plate 2, figure 8a–b

Cytherura scaberrima BRADY, 1887, *Les fonds de la mer*, vol. 4, p. 198, pl. 14, figs. 10–11.

Cythere scaberrima (Brady). – BRADY AND NORMAN, 1889, Roy. Dublin Soc., Sci. Trans., ser. 2, vol. 4, p. 245, text-fig.

This species differs slightly from *Bythoceratina scaberrima* (Brady), the type specimens of which were kindly loaned for comparison by the Hancock Museum, Newcastle-upon-Tyne. In the first place, this species is considerably smaller, and, moreover, the anterior swelling is less well developed, especially dorsally, than in Brady's species. It is closely related to a species living off the coast of Trinidad, which is less spinose in that the row of spines along the dorsal margin is missing. This species was figured by Key (1954, p. 229, pl. 5, fig. 10) as *Bythoceratina* aff. *utilazea* Hornibrook.

So far, seven specimens of this fragile species have been found, but unfortunately only the specimen from the Ste. Croix Quarry is entirely undamaged. This distinct and easily recognizable species has therefore not been given a new specific name. The other specimens occur in the Brasso formation (*Globorotalia fohsi* zone) and in the Los Atajos. Length 0.61 mm.; height 0.34 mm.; width 0.45 mm.

Subfamily XESTOLEBERIDINAE

Genus XESTOLEBERIS Sars, 1866

Xestoleberis sp. aff. **Xestoleberis glabrescens** (Reuss)
Plate 4, figure 6a–b

Cytherina glabrescens REUSS, 1850, Naturw. Abh., vol. 3, pt. 1, p. 59, pl. 10, fig. 27.

Xestoleberis sp. *D*, VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 120, pl. 9, fig. 8.

Xestoleberis glabrescens (Reuss). – KEY, 1955, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, p. 124, pl. 18, fig. 19.

The Trinidad specimens have the same general shape, with angled dorsal margin, as is indicated in Key's figure, but the position of the greatest convexity is situated slightly higher in the posterior end. This difference does not appear sufficient, however, for the establishment of a new species.

The species occurs in the Ste. Croix Quarry, in the Oligocene, and in the lower part of the Miocene (*Globorotalia fohsi* zone). Length 0.43 mm.; height 0.29 mm.; width 0.28 mm.

Xestoleberis dactylotypa van den Bold

Xestoleberis dactylotypa VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 119, pl. 16, fig. 16.

Two crushed specimens that were found in the Morne Diablo Quarry have approximately the same shape as, and the characteristic ornamentation of, *Xestoleberis dactylotypa*. This species has also been found in a sample from the Miocene of the Dominican Republic. Length 0.53 mm.; height 0.32 mm.; width 0.32 mm.

BIBLIOGRAPHY

Publications indicated with an asterisk are mentioned in the synonymies, but could not be consulted.

AKERS, W. H.
1955 – *Some planktonic foraminifera of the American Gulf Coast and suggested correlation with the Caribbean Tertiary.* Jour. Pal., vol. 29, pp. 647–664.

BAIRD, W.
1850 – *The natural history of the British Entomostraca.* London: Ray Society, 364 pp., 36 pls.

BERGQUIST, H. R.
1942 – *Scott County fossils, Jackson foraminifera and Ostracoda.* Mississippi, State Geol. Survey, Bull., no. 49, pp. 5–117, pls. 1–11.

BOLD, W. A. VAN DEN
1946 – *Contribution to the study of Ostracoda with special reference to the Tertiary and Cretaceous microfauna of the Caribbean region.* (Utrecht, Univ., thesis.) Amsterdam: the author, pp. 8–167, pls. 1–18, text-figs. 1–8, tables 1–6, 2 maps.
1950*a* *Miocene Ostracoda from Venezuela.* Jour. Pal., vol. 24, pp. 76–88.
1950*b* *A checklist of Cuban Ostracoda.* Jour. Pal., vol. 24, pp. 107–109.

BORNEMANN, J. G.
1855 – *Die mikroskopische Fauna des Septarienthones von Hermsdorf bei Berlin.* Deutsch. Geol. Ges., Zeitschr., vol. 7, pp. 307–371, pls. 12–21.

BOSQUET, J.
1852 – *Description des entomostracés fossiles des terrains tertiaires de la France et de la Belgique.* Acad. Roy. Sci. Lett. Belgique, Mém. Cour., vol. 24, pp. 1–142, pls. 1–6.

BRADY, G. S.
1866 – *On new or imperfectly known species of marine Ostracoda.* Zool. Soc. London, Trans., vol. 5, pp. 359–393, pls. 57–62.
1868*a* *Ostracoda.* In: FOLIN, L. DE, AND PÉRIER, L., *Les fonds de la mer.* Paris: Vol. 1, livr. 6–7, pp. 49–112.
1868*b* *A monograph of the Recent British Ostracoda.* Linn. Soc. London, Trans., vol. 26, pt. 2, pp. 353–495, 19 pls.
1869 – *Ostracoda.* In: FOLIN, L. DE, AND PÉRIER, L., *Les fonds de la mer.* Paris: Vol. 1, livr. 10, pp. 113–176.
1870 – *Ostracoda.* In: FOLIN, L. DE, AND PÉRIER, L., *Les fonds de la mer.* Paris: Vol. 1, livr. 12–14, pp. 177–256.
1880 – *Report on the Ostracoda.* Rept. Voy. Challenger, Zool., vol. 1, pt. 3, pp. 1–184, pls. 1–44.
1887 – *Description of Ostracoda from the explorations of the Travailleur and the Talisman.* In: FOLIN, L. DE, AND PÉRIER, L., *Les fonds de la mer.* Paris: Vol. 4, pp. 164–226.

BRADY, G. S., AND NORMAN, A. M.
1889 – *Monograph of the marine and freshwater Ostracoda of the North Atlantic and northwest Europe; Sect. I–Podocopa.* Roy. Dublin Soc., Sci. Trans., ser. 2, vol. 4, pp. 63–270, pls. 8–23.

BRONNIMANN, P.
1950 – *Occurrence and ontogeny of Globigerinatella insueta Cushman and Stainforth from the Oligocene of Trinidad (B.W.I.).* Cushman Found. Foram. Res., Contr., vol. 1, pts. 3–4, pp. 80–82, pls. 13–14.

CAPEDER, G.
*1900 – *Contribuzione allo studio degli entomostraci ostracodi dei terreni pliocenici del Piemonte e della Liguria.* R. Accad. Sci. Torino, Atti, vol. 35, pt. 1, pp. 60–73, 1 pl.
*1902 – *Contribuzione allo studio degli entomostraci ostracodi dei terreni miocenici del Piemonte e della Liguria.* R. Accad. Sci. Torino, Atti, vol. 37, pp. 5–18, 1 pl.

CARUS, J. V.
*1885 – *Prodromus faunae Mediterraneae.* Stuttgart: Vol. 1, pt. 2, pp. 289–522.

CHAPMAN, F.
*1906 – *On some foraminifera and Ostracoda obtained off Great Barrier Island, New Zealand.* New Zealand Inst., Trans. Proc., vol. 38 (1905), pp. 77–107, pl. 3.
1916 – *Caenozoic geology of the Mallee and other Victorian bores.* Victoria, Geol. Survey, Rec., vol. 3, pp. 327–430.
1926 – *The Cretaceous and Tertiary foraminifera of New Zealand (with an appendix on the Ostracoda).* New Zealand, Dept. Mines, Geol. Survey, Pal. Bull., no. 11, pp. 1–119, pls. 1–22.

CHAPMAN, F., AND CRESPIN, I.
1928 – *Description of Ostracoda.* In: CHAPMAN, F., *The Sorrento bore, Mornington Peninsula.* Victoria, Geol. Survey, Rec., vol. 5, pp. 5–195, pls. 1–12.

CORYELL, H. N., AND FIELDS, S.
1937 – *A Gatun ostracod fauna from Panama.* Amer. Mus. Nov., no. 956, 18 pp., 2 pls., 1 map.

COSTA, O. G.
*1859 – *Paleontologia del Regno di Napoli; Parte III.* Accad. Pontaniana Napoli, Atti, vol. 8, pp. 157–192, pls. 15–16.

CRESPIN, I.
1948 – *Foraminifera and other microfossils from some of the Tertiary deposits in the vicinity of Ardinga Bay, South Australia.* Roy. Soc. South Australia, Trans., vol. 70, pp. 296–301.

CROUCH, R. W.
1949 – *Pliocene Ostracoda from southern California.* Jour. Pal., vol. 22, pp. 1–46.

CUSHMAN, J. A., AND RENZ, H. H.
1947 – *The foraminiferal fauna of the Oligocene, Ste. Croix formation, of Trinidad, B.W.I.* Cushman Lab. Foram. Res., Spec. Publ. no. 22, pp. 1–46, pls. 1–8.

DROOGER, C. W.
1952 – *Study of American Miogypsinidae.* (Utrecht, Univ., thesis). Zeist, Netherlands: the author, pp. 1–80, pls. 1–3, text-figs. 1–18, tables 1–3.
1954 – *Miogypsinae from northern Italy; I and II.* K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 57, no. 2, pp. 227–247, pls. 1–2, text-figs. 1–5, table 1.
1956 – *Transatlantic correlation of the Oligo-Miocene by means of foraminifera.* Micropaleontology, vol. 2, no. 2, pp. 183–192.

DROOGER, C. W., KAASSCHIETER, J. P. H., AND KEY, A. J.
1955 – *The microfauna of the Aquitanian-Burdigalian of southwestern France.* K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, no. 2, pp. 3–136, pls. 1–20, text-figs. 1–11, tables.

EDWARDS, R. E.
1944 – *Ostracoda from the Duplin marl (U. Miocene) of North Carolina.* Jour. Pal., vol. 18, no. 6, pp. 505–528, pls. 85–88.

EGGER, J. G.
1901 – *Ostrakoden aus Meeresgrundproben gelothet von 1874–1876 von S.M.S. Gazella.* K. Bayer. Akad. Wiss. München, Math.-Physik. Cl., Abh., vol. 21, pt. 2, pp. 413–477, 8 pls.

GRAVELL, D. W., AND HANNA, M. A.
1937 – *The Lepidocyclina texana horizon in the Heterostegina zone, U. Oligocene, of Texas and Louisiana.* Jour. Pal., vol. 11, no. 6, pp. 517–529, pls. 60–65.

GUPPY, R. J. L.
1893 – *Microzoa of the Tertiary and other rocks of Trinidad and the West Indies.* Trinidad Field Nat. Club, Jour., vol. 1, no. 11, pp. 277–290.
1903 – *On some rock samples from borings at Sangre Grande.* Victoria Inst. Trinidad, Proc., vol. 2, pts. 1–5, pp. 1–16, pls. 1–3.

HEJJAS, I.
*1892 – *Erdély tertiär Ostracodai.* Erdélyi Muzeum-Egylet, Értesítö, Orvos-Term. Tud., vol. 17, pt. 2, pp. 153–166, 328–333, pl. 10.

HORNIBROOK, N. DE B.
1952 – *Tertiary and Recent marine Ostracoda of New Zealand, their origin, affinities and distribution.* New Zealand, Geol. Survey, Pal. Bull., no. 18, pp. 5–82, pls. 1–18.

HOWE, H. V.
*1934 – *Guidebook of the 11th annual field trip of the Shreveport Geological Society.* Shreveport: 52 pp., 10 pls.
1935 – *Ostracoda of the Arca zone of the Choctawhatchee Miocene of Florida.* Florida, Dept. Cons., Geol. Bull., no. 13, 47 pp., 4 pls.
1955 – *Handbook of ostracod taxonomy.* Louisiana State Univ. Studies, Phys. Sci. Ser., no. 1, pp. vii–xviii, 1–389.

HOWE, H. V., AND CHAMBERS, J.
1935 – *Louisiana Jackson Eocene Ostracoda.* Louisiana, Dept. Cons., Geol. Bull., no. 5, pp. 1–65, pls. 1–6.

HOWE, H. V., AND LAW, J.
1936 – *Louisiana Vicksburg Oligocene Ostracoda.* Louisiana, Dept. Cons., Geol. Bull., no. 7, 96 pp., 6 pls.

JONES, T. R.
1857 – *Monograph of the Tertiary Entomostraca of England.* Palaeontogr. Soc. London, Monogr., vol. 9, pp. 1–68, pls. 1–6.

JONES, T. R., AND SHERBORN, C. D.
1889 – *A supplementary monograph of the Tertiary Entomostraca of England and Ireland.* Palaeontogr. Soc. London, Monogr., vol. 42, pp. 1–55, pls. 1–3.

KEY, A. J.
1953 – *Preliminary note on the Recent Ostracoda of the Snellius Expedition.* K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 56, no. 2, pp. 155–168, pls. 1–2, map.
1954 – *Ostracoda, identification and description of species.* In: ANDEL, T. VAN, AND POSTMA, H., *Recent sediments of the Gulf of Paria; Reports of the Orinoco shelf expedition, vol. 1.* K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, no. 5, pp. 119–128; app. L, pp. 218–229, pls. 3–6.
1955 – *Part 4: Ostracoda.* In: DROOGER, C. W., KAASSCHIETER, J. P. H., AND KEY, A. J., K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, no. 2, pp. 101–136.

KINGMA, J. T.
1948 – *Contribution to the knowledge of the Young Caenozoic Ostracoda from the Malayan region.* Utrecht, Univ., doct. diss., pp. 1–106, pls. 1–12, 3 figs., 1 chart.

KLÄHN, H.
1917 – *Fossilien des Tertiärs zwischen Lauch und Fecht; III – Ostracoda.* Naturh. Ges. Colmar, Mitt., new ser., vol. 14 (1916–1917), pp. 62–94, pls. 12–14.

KLIE, W.
*1942 – *Adriatische Ostracoden; I – Die Gattung Paradoxostoma.* Zool. Anz., vol. 138, pp. 85–89, text-figs.

KUIPER, W. N.
1918 – *Oligocäne und Miocäne Ostracoden aus den Niederlanden.* Groningen, Univ., thesis, 99 pp., 3 pls.

LEROY, L. W.
1939 – *Some small foraminifera, Ostracoda and otoliths from the Neogene of the Rokan-Tapanoeli area (central Sumatra).* Natuurk. Tijdschr. Nederl.-Indië, vol. 99, pt. 6, pp. 215–296, pls. 1–14.
1943 – *Pleistocene and Pliocene Ostracoda of the coastal region of southern California.* Jour. Pal., vol. 17, pp. 354–373, pls. 58–62, text-figs.
1945 – *A contribution to ostracodal ontogeny.* Jour. Pal., vol. 19, no. 2, pp. 81–86, pl. 9, 2 text-figs.

LIDDLE, R. A.
1946 – *The geology of Venezuela and Trinidad.* Ed. 2. Ithaca, N. Y.: Paleontological Research Institution, 890 pp., ill.

LIENENKLAUS, E.
1894 – *Monographie der Ostracoden des Nordwestdeutschen Tertiärs.* Deutsch. Geol. Ges., Zeitschr., vol. 46, pp. 158–268.
*1896 – *Die Ostracoden aus dem Miozän von Ortenburg in Nieder-Bayern (Kollektion Egger).* K. Bayer. Akad. Wiss. München, Sitzber., vol. 26, pp. 183–207.
1900 – *Die Tertiär Ostracoden des mittleren Norddeutschlands.* Deutsch. Geol. Ges., Zeitschr., vol. 52, pp. 497–550, pls. 19–22, 10 text-figs.

MALKIN, D. S.
1953 – *Biostratigraphic study of Miocene Ostracoda of New Jersey, Maryland and Virginia.* Jour. Pal., vol. 27, no. 6, pp. 761–799, pls. 78–82, text-figs. 1–14, tables 1–2.

MARTIN, J. M.
1939 – *Claiborne Eocene species of the ostracod genus Cytheropteron.* Jour. Pal., vol. 13, no. 2, pp. 176–182, pl. 22.

MEHES, G.
1941 – *Budapest környékének felsöoligocén ostracodai (Die Ostracoden des Oberoligozäns der Umgebung von Budapest).* Geol. Hungarica, Ser. Pal., fasc. 16, pp. 1–95, ill.

MINCHER, A. R.
1941 – *The fauna of the Pascagoula formation.* Jour. Pal., vol. 15, pp. 337–348, pls. 46–47.

MÜLLER, G. W.
1894 – *Die Ostracoden des Golfes von Neapel und der angrenzenden Meeresabschnitte.* In: *Flora und Fauna des Golfes von Neapel; Monogr. 21.* Berlin: Zool. Stat. Neapel, pp. 1–404, pls. 1–40.
1912 – *Ostracoda.* In: SCHULZE, F. E. (ed.), *Das Tierreich.* Berlin: Friedländer, pt. 31, 434 pp., 92 text-figs.

MUNSEY, G. C.
1953 – *A Paleocene ostracode fauna from the Coal Bluff marl member of the Naheola formation of Alabama.* Jour. Pal., vol. 27, no. 1, pp. 1–20, pls. 1–4, text-fig. 1.

NAMIAS, I.
1901 – *Ostracodi fossili della Farnesina e Monte Mario presso Roma.* Palaeontogr. Ital., vol. 6 (1900), pp. 79–114, 2 pls.

NEVIANI, A.
1906 – *Ostracodi delle sabbie postpliocenichi di Carrubara.* Soc. Geol. Ital., Boll., vol. 25, pp. 181–216.
1928 – *Ostracodi fossili d'Italia; I – Vallebriaja (Calabriano).* Accad. Pont. Sci. Nuovi Lincei, Mem., ser. 2, vol. 11, pp. 1–120, pls. 1–2.

PURI, H. S.
1953*a* *The ostracode genus Hemicythere and its allies.* Washington Acad. Sci., Jour., vol. 43, no. 6, pp. 169–179, pls. 1–2.
1953*b* *Contribution to the study of the Miocene of the Florida Panhandle.* Florida, Geol. Survey, Geol. Bull., no. 36, pp. 217–309, pls. 1–17.
1955 – *Hermanites, new name for Hermania Puri, 1953.* Jour. Pal., vol. 29, no. 3, p. 558.
1956 – *Two new Tertiary ostracode genera from Florida.* Jour. Pal., vol. 30, no. 2, pp. 274–277, pls. 35–36.

RENZ, H. H.
1942 – *Stratigraphy of northern South America, Trinidad and Barbados.* Amer. Sci. Congr., 8th, Proc., vol. 4 (Geol. Sci.), pp. 513–517, 1 table.

REUSS, A. E.
1850 – *Fossilen Entomostraceen des österreichischen Tertiärbeckens.* Naturw. Abh., vol. 3, pt. 1, pp. 41–92, pls. 8–11.
1851 – *Foraminiferen und Entomostraceen des Septarienthons der Umgebung von Berlin.* Deutsch. Geol. Ges., Zeitschr., vol. 3, no. 2, pp. 49–92, pls. 3–7.

ROME, R.
1939 – *Notes sur les ostracodes marins des environs de Monaco.* Monaco, Inst. Océanogr., Bull., no. 768.
1942 – *Ostracodes marins des environs de Monaco.* Monaco, Inst. Océanogr., Bull., no. 819, pp. 1–32, pls. 1–7, text-figs.

RUGGIERI, G.
1950 – *Gli ostracodi delle sabbie grigie Quaternarie (Milazziano) di Imola; Parte I.* Giorn. Geol., ser. 2, vol. 21, pp. 1–57, text-figs. 1–34, pl. 1.
1952*a* *Nota preliminare sugli ostracodi di alcune spiaggie adriatiche.* Bologna, Univ., Ist. Zool., Lab. Biol. Mar. Fano, Note, vol. 1, no. 8, pp. 57–64, text-figs. 1–4.
1952*b* *Gli ostracodi delle sabbie grigie Quaternarie (Milazziano) di Imola; Parte II.* Giorn. Geol., ser. 2, vol. 22, pp. 59–115, pls. 1–8.
1953*a* *Iconografia degli ostracodi marini del Pliocene e del Pleistocene italiani.* Soc. Ital. Sci. Nat., Atti, vol. 92, no. 1, pp. 40–56.
1953*b* *Correzioni ad alcuni lavori su ostracodi dell'autore stesso.* Giorn. Geol., ser. 2, vol. 23, pp. 169–170.
1953*c* *Età e fauna di un terrazzo marino sulla costa ionica della Calabria.* Giorn. Geol., ser. 2, vol. 23, pp. 19–168.

RUTSCH, R.
1934 – *Beiträge zur Kenntnis tropisch-amerikanischer Tertiärmollusken; II – Pteropoden und Heteropoden aus dem Miocaen von Trinidad (Brit. Westindien).* Eclogae Geol. Helv., vol. 27, no. 2, pp. 299–326, pl. 8, 1 text-fig.

SEGUENZA, G.
*1880 – *Le formazioni tertiarie nella provincia di Reggio.* R. Accad. Lincei Roma, Cl. Sci. Fis. Mat. Nat., Mem., ser. 3, vol. 6, 445 pp., 17 pls.
*1884 – *Gli ostracodi del porto di Messina.* Naturalista Siciliano, vol. 3 (1883–1884), pp. 39–42; 75–78; 124–128; 149–152; 253–257; 319–322.

SKOGSBERG, T.
1928 – *Studies on marine Ostracoda; Part II – External morphology of the genus Cythereis and descriptions of twenty-one new species.* California Acad. Sci., Occ. Papers, no. 15, pp. 1–144, pls. 1–6, 23 text-figs.

SMITH, R. H.
1941 – *Micropaleontology and stratigraphy of a deep well at Niceville, Okaloosa County, Florida.* Amer. Assoc. Petr. Geol., Bull., vol. 25, no. 2, pp. 263–286, pls. 1–2.

STEPHENSON, M. B.
1935 – *Some microfossils of the Potamides matsoni zone of Louisiana.* Louisiana, Dept. Cons., Geol. Bull. no. 6, pp. 187–196, pl. 5.
1938 – *Miocene and Pliocene Ostracoda of the genus Cytheridea.* Jour. Pal., vol. 12, no. 2, pp. 127–148, pls. 23–24, text-figs. 1–20.
1944 – *New Ostracoda from subsurface middle Tertiary strata of Texas.* Jour. Pal., vol. 18, no. 2, pp. 127–161, pl. 28.

SWAIN, F. M.
1946 – *Ostracoda from the Tertiary of Florida.* Jour. Pal., vol. 20, no. 4, pp. 374–383, pls. 54–55.
1948 – *Ostracoda from the Hammond well.* Maryland, Dept. Geol., Mines and Water Resources, Bull., no. 2, pp. 187–213, pls. 12–14.
1951*a* *Corrections: Recent papers on Mesozoic and Cenozoic Ostracoda.* Jour. Pal., vol. 25, no. 2, p. 236.
1951*b* *Ostracoda from wells in North Carolina; Part I – Cenozoic Ostracoda.* U. S. Geol. Survey, Prof. Paper no. 234–A, pp. i–iii, 1–58, pls. 1–7, text-figs. 1–3.
1955 – *Ostracoda of San Antonio Bay, Texas.* Jour. Pal., vol. 29, no. 4, pp. 561–646, pls. 59–64, text-figs. 1–39.

TRIEBEL, E.
1941 – *Zur Morphologie und Ökologie der fossilen Ostracoden.* Senckenbergiana, vol. 23, no. 4–6, pp. 294–400, pls. 1–15, text-figs. 1–2.

ULRICH, E. O., AND BASSLER, R. S.
1904 – *Ostracoda.* Maryland, Geol. Survey, Miocene, pp. 98–130, pls. 35–38.

WARING, G. A.
1926 – *The geology of the Island of Trinidad.* Johns Hopkins Univ., Studies in Geol., no. 7, pp. 48–52.

WEINGEIST, L.
1949 – *The ostracode genus Eucytherura and its species from the Cretaceous and Tertiary of the Gulf Coast.* Jour. Pal., vol. 23, no. 4, pp. 364–379, pl. 73, table 1.

EXPLANATION OF PLATES

PLATE 1

All figures × 50 unless otherwise specified.

1 *Cytherella* sp. aff. *Cytherella pulchra* Brady
Left valve view of complete specimen. Ste. Croix Quarry.

2 *Cytherella polita* Brady
a, left valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

3 *Cytherella* sp.
Left valve view of complete specimen. Mejias Quarry.

4 *Paracypris rosefieldensis* Howe and Law
Right valve view of complete specimen. Morne Diablo Quarry.

5 *Bairdia bradyi* van den Bold, new name
Left valve view of complete specimen. Ste. Croix Quarry.

6 *Bairdia amygdaloides* Brady
a, right valve view of complete specimen, Ste. Croix Quarry; b, right valve view of complete specimen, Morne Diablo Quarry.

7 *Haplocytheridea* sp. cf. *Haplocytheridea waltonensis* (Stephenson)
Right valve view of complete specimen. Quinam Quarry.

8 *Aurila deformis* (Reuss)
Right valve view of complete specimen. Ste. Croix Quarry.

9 *Hemicythere antillea* van den Bold
a, right valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

10 *Trachyleberis reticulospinosa* (van den Bold)
Exterior of right valve. Morne Diablo Quarry.

11 *Trachyleberis? hazelae* (van den Bold)
Exterior of right valve. Trinidad Point calcareous clay (K. 5774).

12 *Orionina bermudae* (Brady)
a, anterior marginal area of right valve; b, posterior marginal area of right valve. Melajo beds; × 150.

PLATE 2

All figures × 80.

1 *Hermanites haidingeri* (Reuss)
a, exterior of right valve; b, interior of same valve. Red Bluff, highest part of cliff at Hiwannee, Mississippi.

2 *Hermanites? pannosa* (Brady)
Right valve view. Ste. Croix Quarry.

3 *Bradleya* sp.
a, right valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

4 *Costa variabilocostata* (van den Bold)
Right valve view of complete specimen. Ste. Croix Quarry.

5 *Costa santacrucensis* van den Bold, n. sp.
a, exterior of right valve, female; b, right valve view of complete carapace, male. Tunnel Hill member of the Brasso formation (Rohr sample 12305).

6 *Cativella* sp. cf. *Cativella semitranslucens* (Crouch)
Exterior of right valve. Quinam Quarry.

7 *Loxoconcha fischeri* (Brady)
Left valve view of complete specimen. Morne Diablo Quarry.

8 *Bythoceratina* sp. aff. *Bythoceratina scaberrima* (Brady)
a, exterior of right valve, Ste. Croix Quarry; b, dorsal view of complete specimen, Brasso formation (Rohr sample 11975).

PLATE 3

All figures × 80.

1 *Hermanites hutchisoni* van den Bold, n. sp.
a, right valve view of complete carapace; b, dorsal view of same specimen. Ste. Croix Quarry.

2 *Campylocythere striata* van den Bold, n. sp.
a, right valve view of complete specimen, Ste. Croix Quarry; b, dorsal view of same specimen; c, interior of left valve, Recent, Gulf of Paria; d, interior of right valve, Recent, Gulf of Paria.

3 *Perissocytheridea matsoni* (Stephenson)
Right valve view of complete specimen. Ste. Croix Quarry.

4 *Munseyella mühlemanni* van den Bold, n. sp.
a, right valve view of complete specimen; b, dorsal view of complete specimen; c, interior of right valve. All from the Cruse formation, Sullivan hole no. 204.

5 *Cytheromorpha* sp. aff. *Cytheromorpha warneri* Howe and Spurgeon
a, right valve view of complete carapace; b, dorsal view of same specimen. Mejias Quarry.

6 *Caudites medialis* Coryell and Fields
Right valve view of complete specimen. Ste. Croix Quarry.

7 *Caudites fragilis* LeRoy
Right valve view of complete specimen. Ste. Croix Quarry.

8 *Caudites sellardsi* (Howe and Neill)
Exterior of left valve. Ste. Croix Quarry.

9 *Puriana* sp. aff. *Puriana puella* (Coryell and Fields)
a, exterior of right valve; b, dorsal view of complete carapace. Both from the Ste. Croix Quarry.

10 *Hemicythere palosensis* LeRoy
a, right valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

PLATE 4

All figures × 80 unless otherwise specified.

1 *Microcythere johnsoni* Mincher
Exterior of left valve. Ste. Croix Quarry.

2 *Cyprideis mayi* (Stephenson)
Exterior of left valve. Ste. Croix Quarry.

3 *Clithrocytheridea reticulata* van den Bold, n. sp.
a, right valve view of complete specimen, Ste. Croix Quarry; b, dorsal view of same specimen; c, interior of right valve, × 150, Recent, Gulf of Paria.

4 *Cytheropteron leonensis* Puri
a, right valve view of complete specimen; b, dorsal view of same specimen. Morne Diablo Quarry.

5 *Cytheropteron renzi* van den Bold, n. sp.
a, right valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

6 *Xestoleberis* sp. aff. *Xestoleberis glabrescens* (Reuss)
a, right valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

7 *Paracytheridea tschoppi* van den Bold
Exterior of left valve. Ste. Croix Quarry.

8 *Aurila trigonula* (Jones)
Right valve view of complete specimen. Ste. Croix Quarry.

9 *Pellucistoma kendengensis* (Kingma)
Right valve view of complete specimen. Ste. Croix Quarry.

10 *Cytherura hermesi* van den Bold
a, left valve view of complete specimen; b, dorsal view of same specimen. Ste. Croix Quarry.

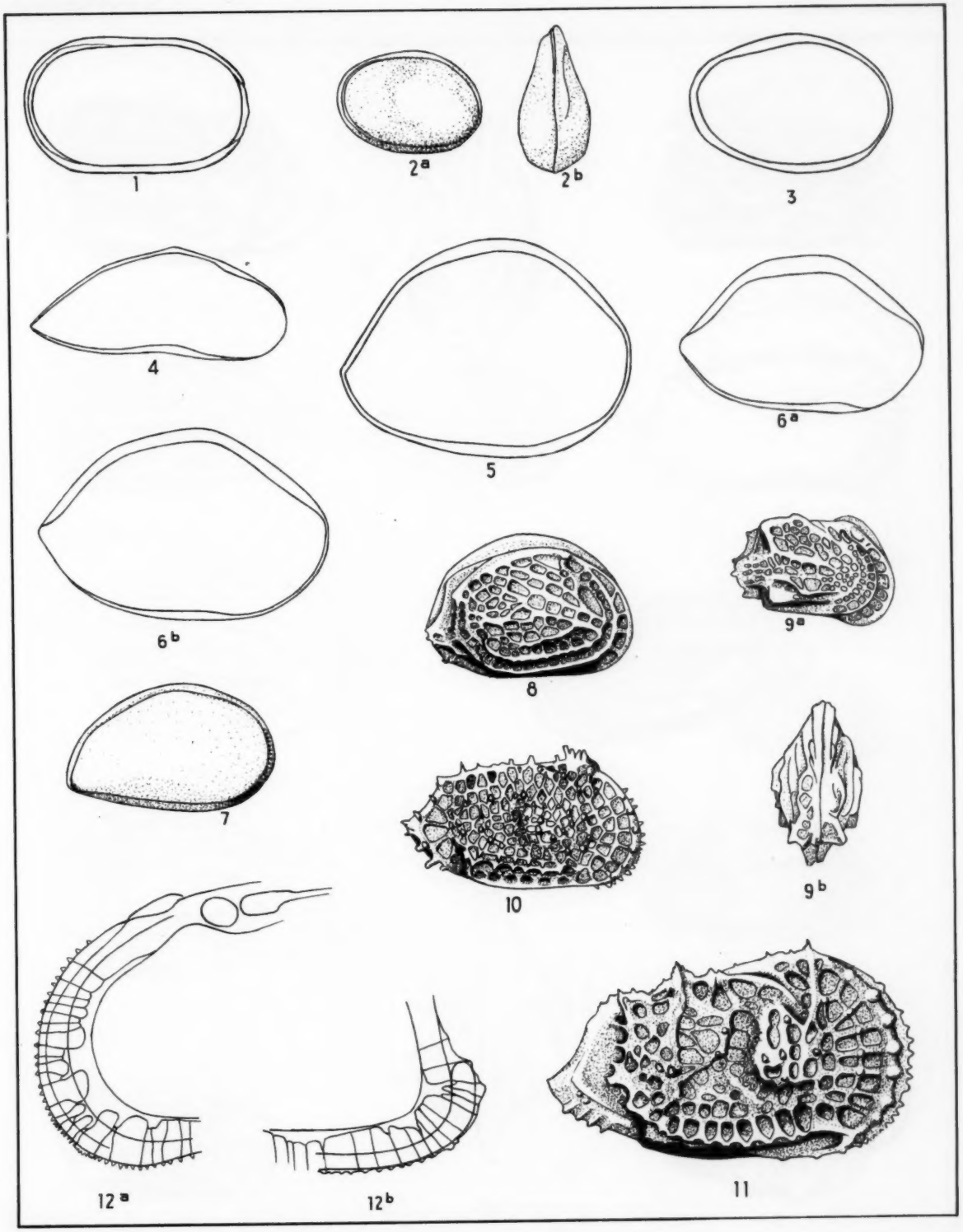
11 *Cytherura* sp.
Left valve view of complete specimen. Morne Diablo Quarry.

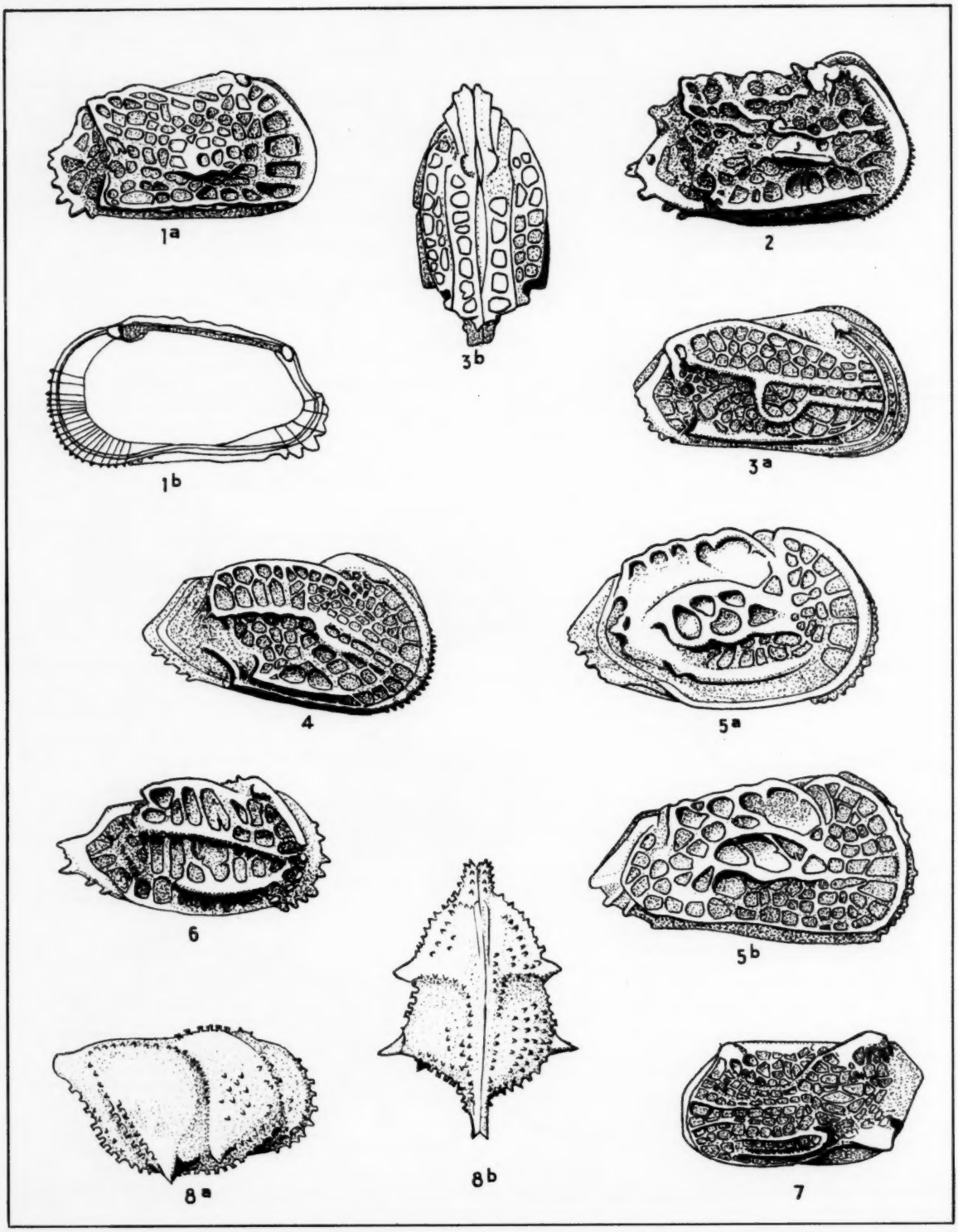
12 *Hemicytherura videns* (Müller)
Left valve view of complete specimen. Ste. Croix Quarry.

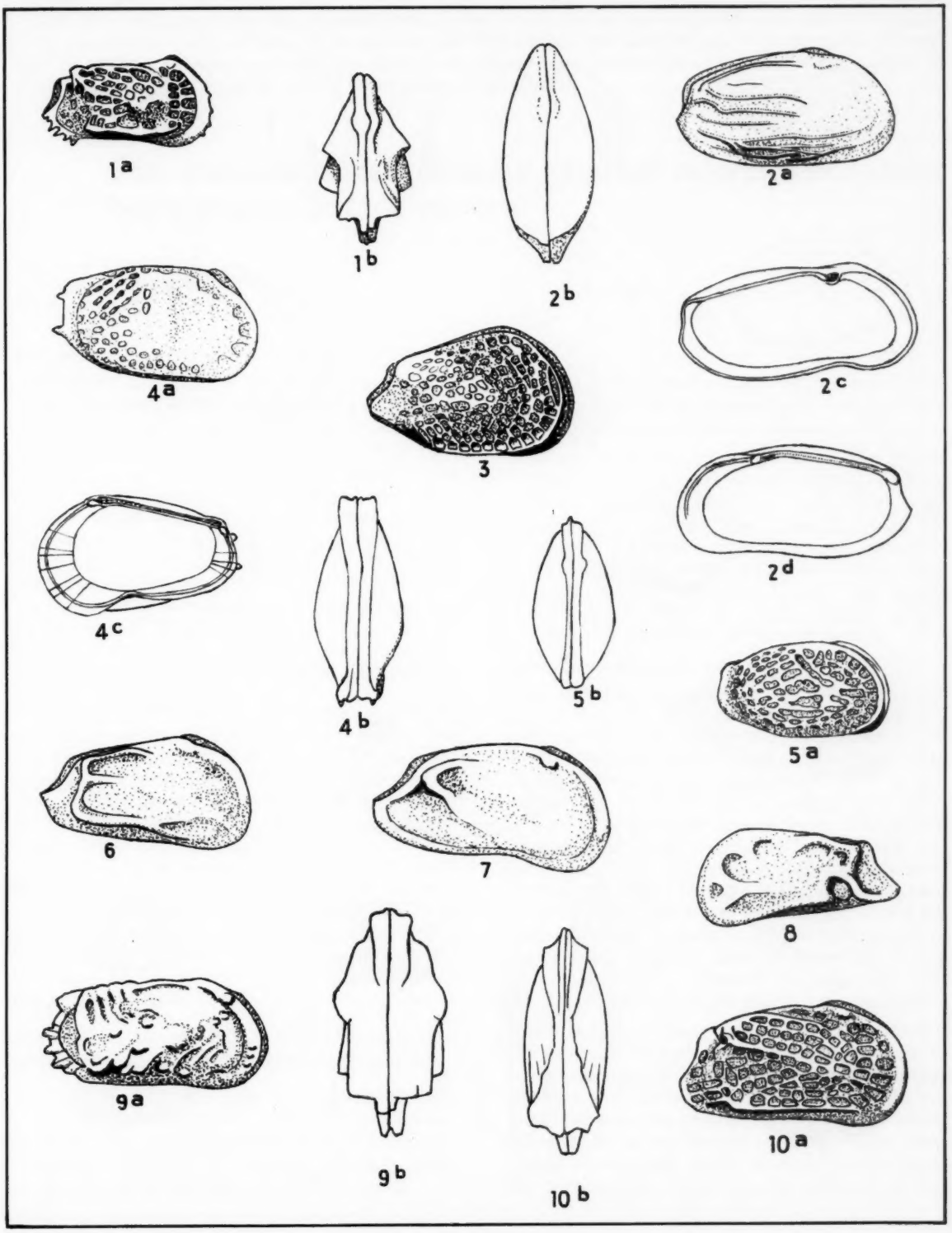
13 *Loxoconcha banesensis* van den Bold
Right valve view of complete specimen. Ste. Croix Quarry.

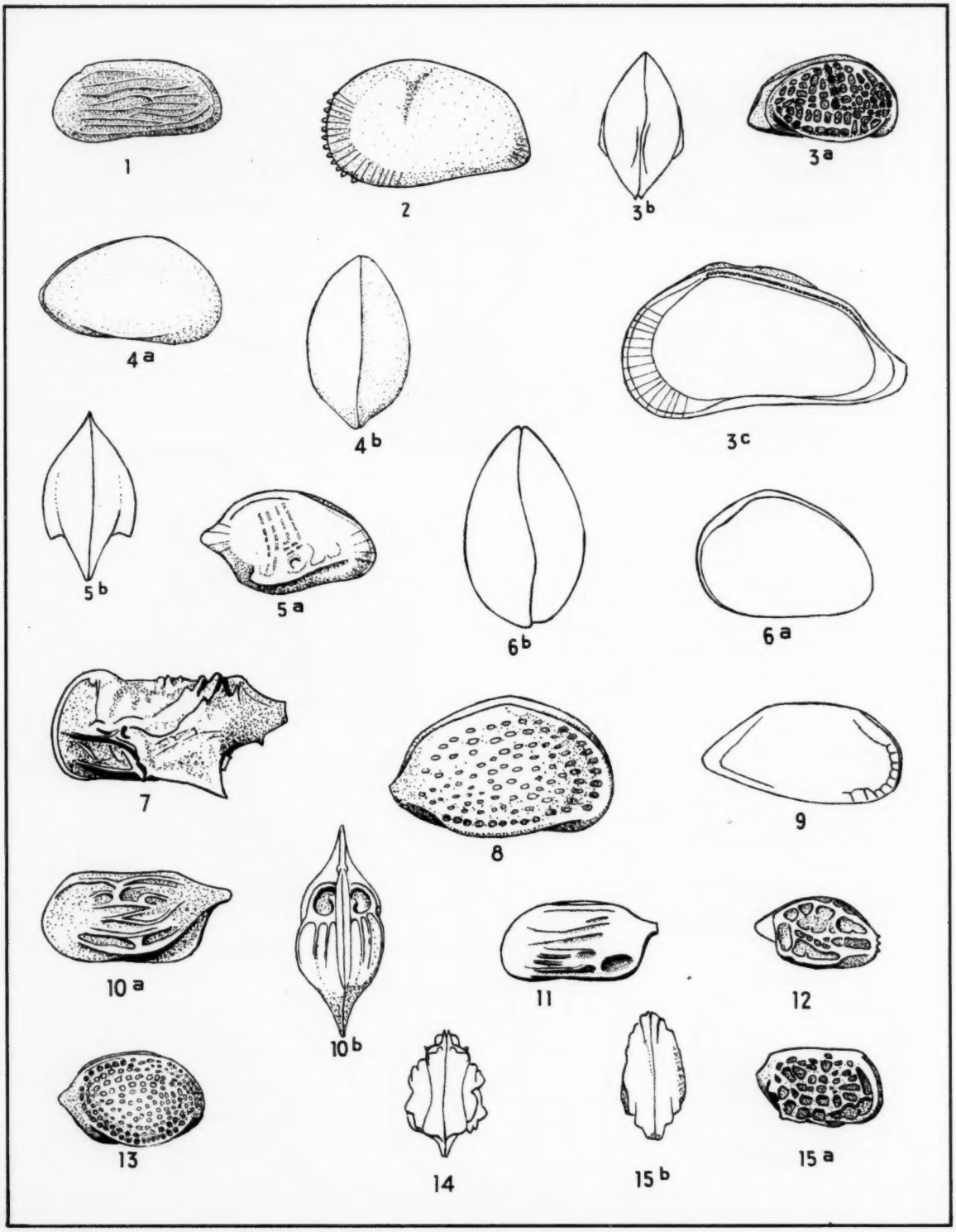
14 *Eucytherura complexa* (Brady)
Dorsal view of complete specimen. Morne Diablo Quarry.

15 *Eucytherura* sp. cf. *Eucytherura gullentopsi* Ruggieri
a, right valve view of complete specimen; b, dorsal view of same specimen. Morne Diablo Quarry.


1
2a
2b
3
4
5
6a
6b
8
9a
7
10
9b
12a
12b
11


1a
3b
2
1b
3a
4
5a
6
5b
8a
8b
7


1a
1b
2b
2a
4a
2c
3
4c
2d
4b
5b
5a
6
7
8
9a
9b
10b
10a


1
2
3b
3a
4a
4b
3c
5b
5a
6b
6a
7
8
9
10a
10b
11
12
13
14
15b
15a

ABSTRACT: *Names of fossil pollen and spores to be published and used in scientific work must conform to the International Code of Botanical Nomenclature. Private nomenclatorial systems may be used but have no scientific status. Pollen belonging to extant taxa must be referred to them, despite assertions that only artificial taxa should be used for fossil pollen. Dispersed fossil pollen forms belonging to extant genera should be described as organ species, a procedure that eliminates many of the objections raised against the use of names of extant genera for microfossils.*

The nomenclatural problem of plant microfossil species belonging to extant genera

ALFRED TRAVERSE
Shell Development Company
Houston, Texas

INTRODUCTION

The alleged difficulties of published nomenclature of fossil pollen and spores are not really difficulties. They are covered by the International Code of Botanical Nomenclature. For example: what to do with fossil pollen and spores of unknown affinity? Form genera created and subsequently treated according to the Code are required. The difficulties of procedure are simply those faced by all paleobotanists. Potonié (1956*a*, p. 86) has stated, "... die zur Zeit geltenden Bestimmungen des Internationalen Code der Botanischen Nomenklatur im allgemeinen genügen, um die Sporae dispersae einheitlich zu behandeln." Except that "im allgemeinen" seems an unnecessary limitation, I entirely agree with Potonié.

Recurring will-of-the-wisps are proposals that the way out of nomenclatural difficulty for fossil pollen is a special code system to replace the international rules. Such a system is very useful for the stratigraphic palynologist and is not at all in conflict with the International Code. The names in a special code system simply have nothing to do with valid nomenclature, and should not be used in published papers as if they were plant names. In published papers a unit that has enough distinctness to be referred to as *XY*–1 should be given a valid name, if the author intends that the name be used in the scientific literature. *XY*–1 is, after all, a binomial name, albeit not a permissible one.

Within the International Code, the following sorts of generic names for fossil entities are recognized:

1) *Form genera.* In the words of Schopf (1949) these are genera "maintained for classifying fossil specimens that lack important diagnostic characteristics indicative of natural affinity." These genera are always artificial to some degree.
2) *Organ genera.* These are genera that include organs of the same morphological category and which have known natural affinity.
3) *Natural genera*, i.e., genera of whole, unified plants. These are at present always genera of extant plants. At some time in the future all the fossil organ genera of some fossil plants may be united to form a natural genus. At present, however, all strictly fossil genera are either form or organ genera, and the only natural genera that include fossil plants are certain genera of extant plants, which are represented in the fossil record.

NATURAL GENERA AND FAMILIES AS FOSSILS

Since nature is a continuum, it is evident that certain taxa of all levels, infraspecific units, species, genera, families, will occur both as members of the extant flora and as fossils. In the classification of fossil plant organs of Tertiary and Quaternary age, it is also evident that one must deal with a certain proportion of organs, progressively greater from Paleocene to Pleistocene, that fall within the limits of taxa described originally for extant plants. Paleobotanists studying megafossil organs have placed the organs in extant taxa, where they felt that the organs fell within the limits of the taxa concerned. If new organ genera were required, these were arrayed in the appropriate family, if known. In other instances, new organ species of extant genera were required.

Pollen analysts studying the so-called subfossil pollen of the Pleistocene have always referred the forms to extant taxa, species, genera, and families, whenever the taxa were believed to be accurately known. Many palynologists studying pre-Pleistocene pollen referable to extant groups, however, have been critical of use of the names of extant taxa for these microfossils. They have felt that pollen does not

often provide sufficient information for certain reference to extant taxa, and that the only safe and sure ground is the use of artificial taxa for *all* fossil pollen, regardless of known relationship of the fossils to extant taxa.

Potonié (1956*a*) has clearly condemned the use of extant generic and specific names for fossil pollen, and it is plain that he also feels that names of extant families ought not to be used formally for fossil pollen. He states that fossil plant organs ought to be rigorously placed in organ and form genera even though the material is referable to extant genera according to the available information. Pflug (1953) has defended essentially the same view. The extremists in this "rigorous" approach would even combine in the same genera forms known to be unrelated. For example, a collaborator of Pflug's, the late F. Mürriger (personal communication, 1953) would seem to have epitomized this viewpoint in a letter to me in which he stated: "As the merely descriptive principle of Thomson and Pflug must not be mixed with other principles and must consequently [be] carried through, there can sometimes be the result of putting pollen grains into the same form genus, although they are known to belong to different families. That is not fine [sic], no doubt, but it is merely a defect of beauty, not a defect in the matter itself, and...a necessary inconvenience and at the same time a minor inconvenience."

USE OF NAMES OF EXTANT GENERA FOR FOSSILS

Objections

Dispersed fossil pollen, in my view, should be referred to organ species, not natural species, inasmuch as discrete fossil pollen forms cannot be depended on to have circumscription comparable to that of natural species. Furthermore, all fossil pollen and spores of unknown or doubtful botanic relationship obviously must be placed in artificial taxa. In other words, I am essentially in agreement with Potonié's recent publications, except that I feel that organ species of fossil pollen can be placed in extant genera in many instances, whereas Potonié is of the opinion that no extant taxa of any rank should be used for any fossil organs.

Palynologists who are against referring fossil pollen to extant genera reason as follows:

a) A rigorous system of palynological nomenclature is required. Therefore, natural genera should not be "mixed" with organ and form genera in this system.

b) The International Code (they say) does not provide for comprehension of fossil and extant material in the same taxa, and, in particular, the rules do not permit fossil species of genera that were described for extant type species.

c) It is impossible to be certain whether a fossil pollen form of known affinity to an extant genus represents one natural species or several. In fact, pollen of known family relationship may belong to one of several natural genera, or to no known natural genus.

Potonié (1956*a*, p. 73) states: "Bei diesen Beispielen muß gesagt werden, daß die Formen zwar in den herangezogenen Gattungen gegeben sind, jedoch in anderen Gattungen hinübergreifen, weshalb es unexakt ist, sie auf die genannten Gattungen einzuschränken." Potonié (1956*b*, p. 91) further states: "Wenn dennoch für die dispergierten Sporen nicht *Sciadopitys*, sondern der unverbindlichere Name *Sciadopityspollenites* vorzuziehen ist, so deshalb, weil in Betracht gezogen werden muß, daß es *Sciadopitys* sehr nahestehende Gattungen gegeben haben könnte, die einen sehr ähnlichen Pollen besessen haben."

It is asserted that the pollen alone provides too little evidence for the erection of a new species of the extant genus, or of a new genus of the plant family concerned. Potonié (1956*a*, pp. 73–74) states that he regards inclusion of fossil pollen in extant genera as indefensible, since this expands the genus beyond its defined limits. He writes:

"Aber sofern man diesen einen neuen Speziesnamen geben muß, weil man sie keiner bekannten Art völlig gleichsetzen kann, so ist es auch hier ± unexakt, sie unmittelbar in eine Gattung ganzer Pflanzen zu bringen. Es würde sich hiermit um eine Erweiterung der Gattung handeln, lediglich auf Grund von Sporen, die bisher noch nicht in dieser Gattung vorhanden waren. Um das zu beurteilen, braucht man von der Pflanze mehr als nur die Sporen.

"Gibt man einer dispersen Spore einen besonderen Speziesnamen, so will man damit ja doch u. a. ausdrücken, es sei nicht möglich oder angebracht, diese Spore mit denen einer bekannten lebenden oder fossilen Pflanze völlig zu identifizieren. Stellt man nun diese Sporen-Spezies z. B. in eine rezente Pflanzengattung, so bedeutet das in vielen Fällen eine Erweiterung dieser Gattung nur auf Grund von Sporen. Eine Spore, die anders aussieht als die bisher in einer rezenten Gattung vertretenen, kann man nicht ohne Bedenken in diese Gattung stellen."

Justifications

In reply to the points presented above, I offer the following arguments:

First, there is no justification for the notion that a separate system of nomenclature is required for publication of fossil pollen and spores. (As explained

above, this does not refer to code systems used by stratigraphic palynologists in their own work.) Pollen and spores are discrete organs with well demarcated and definable morphological and anatomical features. There could scarcely be professional palynologists if this were not true. Recognizing that pollen and spores are identifiable organs and that palynology is a branch of botany, let us refer to the International Code of Botanical Nomenclature (1956), which code is binding on all botanists. The following provisions of the Code seem especially pertinent:

PREAMBLE: "Botany requires a precise and simple system of nomenclature used by botanists in all countries, dealing, on the one hand, with the terms which denote the ranks of taxonomic groups or units, and on the other hand with the names which are applied to the individual taxonomic groups. The purpose of giving a name to a taxonomic group is not to indicate its characters or history, but to supply a means of referring to it and to indicate its taxonomic rank. This Code aims at the provision of a stable method of naming taxonomic groups, avoiding and rejecting the use of names which may cause error or ambiguity or throw science into confusion...."

"The Rules and Recommendations apply throughout the plant kingdom, Recent and fossil...."

Article 7; Note 5: "The typification of organ genera, form genera, genera based on plant microfossils (pollen, spores, etc.)...does not differ from that indicated above."

Article 62: "A legitimate name or epithet must not be rejected merely because it is inappropriate or disagreeable, or because another is preferable or better known, or because it has lost its original meaning."

Appendix II; Article PB. 2: "The general rules applicable to the naming of Recent plants apply also to the names of fossil plants and to those of organ-genera and form-genera."

Quotations from scripture are a facile way of proving what one wants to prove, but it is pertinent here to establish that the International Code does indeed apply to the science of palynology, with no qualifications whatsoever.

Secondly, it is perfectly clear from the Code that there is no barrier to the inclusion of fossil organ species in genera described from extant type species. It may be that some have misinterpreted Article 58. In fact, Article 58 proves that extant genera can have fossil species:

"When a taxon of Recent plants, algae excepted, and a taxon of the same rank of fossil or subfossil plants are united, the correct name or epithet of the former taxon must be accepted, even if it is antedated by that of the latter. Example: If *Sequoia* Endl. (1847), a genus of Recent plants, and *Steinhauera* Presl (1838), a genus of fossil plants, are united, the name *Sequoia* must be accepted for the combined genus, although it is antedated by *Steinhauera*."

Note that in the example stated, the fossil organ species of *Steinhauera* are made species of the extant genus *Sequoia*. It is clear that such combinations are legal and normal.

The concept of organ species: Most of the practical problems of proper nomenclature for fossil pollen belonging to extant taxa relate to what is called by taxonomists the circumscription of the taxa, i.e., what the taxa include. That is, the problem that seems insoluble to some is that a fossil pollen form known to belong to an extant genus may have been produced by plants of several extinct species of that genus, or that the pollen of several related genera may be inseparable. It is argued, then, that it is wrong to imply that the pollen form represents one natural species. Furthermore, Potonié (as quoted above) states that the definition of an extant genus is unfairly expanded by inclusion within it of fossil organ species. In other words, the argument is that the circumscription of discrete fossil pollen forms is not always comparable with that of the natural genera and species of a family. (This is true, although as we learn more of pollen morphology and anatomy, it is becoming evident that pollen is more susceptible to separation and distinction than was formerly realized.)

It is apparent that the source of this objection is insufficient understanding of the categories of taxa recognized for fossil plants. If the taxa described for fossil pollen are recognized for what they are—organ taxa—the difficulties are eliminated. An organ genus is not the same as a natural genus, and the conception and definition of an organ genus implies that the circumscription of an organ genus is, or at least may be, different from that of a natural genus. A pollen genus might well include material from two or more natural genera if we knew the whole plants. Study of the related living forms may show that a fossil pollen form cannot be referred specifically to one of several extant genera, since these are not separable by their pollen. In such a case, the organ genus that must be used obviously has a different circumscription from a natural genus. Yet there is no reason why such an organ genus should not be placed in the natural family to which it is known to belong.

In addition to organ genera, there are organ species, and the principal purpose of this paper is to back strongly the idea that fossil species of extant genera are organ species and that the recognition of this

fact helps one greatly in handling nomenclatural problems. That all fossil species of extant genera are organ species, not natural species, is evident. Species of extant genera described from leaves of the Latah formation or from pollen of the Brandon formation are alike in being organ species; that is, they are species described for dispersed organs. As is true of organ genera as compared with natural genera, organ species do not necessarily have circumscription comparable with that of natural species—an organ species might very well include fossils representing several natural species if the whole plant were known.

Potonié's argument that inclusion of new organ species in an extant genus involves a broadening of the genus does not seem correct to me, because the circumscription of the genus is established by its description. The limits within which species of the genus can vary are therefore established, though they may not be stated for each organ in the generic description. If a fossil pollen species does not fall within this circumscription, it would indeed expand the genus, but in such an instance the pollen species should be put in another genus, perhaps a new organ genus if circumstances warrant. It is not true that each new species described in a genus expands the circumscription of the genus.

The common objections to creating fossil species of extant genera are eliminated by regarding these species as organ species. To take examples from the pollen flora of the Brandon lignite (Traverse, 1955):

1) Three species of *Nyssa* pollen were recognized in the Brandon formation, yet there are something like eight or nine species of fruit endocarps of *Nyssa* in the formation. Unless one recognizes that the pollen species and the endocarp species are organ species, this situation is perplexing, as there is no way of knowing which endocarp form belongs to which pollen form, and one contemplates future textbooks saying that there are a dozen species of *Nyssa* in the Brandon lignite, when it is likely that there are half that many natural species.
2) One form of pollen, one of wood, and one of capsules of *Gordonia* were found. Conservative procedure is to publish three organ species of *Gordonia*, because each organ form is separate and dispersed. However, when there occur in the same sediment several different organs of a single extant genus, and only one form of each organ, it can usually be argued that it is so strongly probable that a single natural species is represented that the several organ forms can be described together as one natural species. The decision as to which procedure to follow must be made in the best judgment of the investigator, according to the evidence in each case. If organ species are described, we must remember that whether or not there are three organ species of *Gordonia* in the Brandon lignite is not related to how many natural species of *Gordonia* there were in the Brandon-time flora.
3) Well-characterized fossil pollen of the Rutaceae were found but seemed different from any rutaceous pollen examined, or any described in the literature. A new organ genus of Rutaceae was described for this pollen form. If this were regarded as creating a new natural genus of the family, it would be adventurous to base it on pollen only. The pollen might represent several species or even several genera of rutaceous plants. But if the new entity is recognized as an organ species of an organ genus, the difficulties are eased.

It also helps to be aware that revision is always possible. Some of a given author's entities may prove to be synonyms for forms already in the literature. Some other palynologist may decide that the microfossils that one author refers to the genus *Nyssa* really belong in a certain cornaceous genus, or in an organ genus, instead. If so, the International Code provides all the machinery for proper transfer.

BIBLIOGRAPHY

LANJOUW, J. (ED.), AND OTHERS
1956 – *International Code of Botanical Nomenclature.* (Adopted by the Eighth International Botanical Congress, Paris, July, 1954.) Utrecht, Netherlands: International Bureau for Plant Taxonomy and Nomenclature of the International Association for Plant Taxonomy.

PFLUG, H.
1953 – In: THOMSON, P. W., AND PFLUG, H., *Pollen und Sporen des mitteleuropäischen Tertiärs.* Palaeontographica, pt. B, vol. 94, nos. 1–4, pp. 1–138, pls. 1–15.

POTONIÉ, R.
1956*a* *Die Behandlung der Sporae dispersae und der fossilen Pflanzen überhaupt nach dem Internationalen Code der Botanischen Nomenklatur.* Pal. Zeitschr., vol. 30, nos. 1–2, pp. 69–87.
1956*b* *Die stratigraphische Inkongruität der Organe des Pflanzenkörpers.* Ibid., vol. 30, nos. 1–2, pp. 88–94.

SCHOPF, J. M.
1949 – In: JUST, T., JOHNSON, J. H., MASON, H. L., AND RADFORTH, N. W., *International Rules of Botanical Nomenclature; American proposals concerning paleobotanical nomenclature.* Chicago: Chicago Natural History Museum, p. 1.

TRAVERSE, A.
1955 – *Pollen analysis of the Brandon lignite of Vermont.* U. S. Bureau of Mines, Rept. Invest. no. 5151, 107 pp.

Publication no. 109, Shell Development Company, Exploration and Production Research Division, Houston, Texas.

ABSTRACT: *The genus* Nezzazata *Omara is recorded from strata of late Cenomanian to earliest Turonian(?) age in Israel.* Begia *Smout is regarded as a junior synonym of* Nezzazata. *The systematic position of this genus is briefly discussed.*

Occurrence of Nezzazata in Israel

Z. REISS
Geological Survey of Israel
Jerusalem

INTRODUCTION

The genus *Nezzazata* Omara, 1956, is one of the characteristic foraminifera in strata of late Cenomanian and possibly earliest Turonian age in Israel. Specimens of this genus have been recorded for many years by this writer as "*Valvulammina?* 17" (unpublished reports). Smout (1956) described the genus *Begia* and referred it to the Ceratobuliminidae. A study of material from Israel shows that 1) *Begia* must be considered a synonym of *Nezzazata*, and 2) neither of them can be included in the Ceratobuliminidae.

The writer feels greatly indebted to his assistant, Mrs. P. Merling, for preparing a number of oriented thin sections of specimens of *Nezzazata*, and to Messrs. "Matsada," United Petroleum Drilling Co. Ltd., for permission to publish information on material from the Sinaf oil-licence area. The material from Beer-Ora was collected by A. Braunfeld, of the Geological Survey of Israel.

THE GENUS NEZZAZATA OMARA, 1956

This genus was originally described from the lower Cenomanian of the western coast of the Sinai Peninsula. It was recorded as occurring with species of *Thomasinella* and *Cribrostomoides*. *Nezzazata* was defined (Omara, 1956) as having single-layered walls, single-walled septa, and a calcareous granular, finely perforate wall structure. The aperture was stated to have a "flattened tooth-like outgrowth of the wall of various shapes," and the chambers were indicated as "without supplementary chamberlets." The photomicrographs published by Omara (1956, pl. 102, figs. 7–13) leave little doubt concerning the true nature of the apertural "outgrowth," viz., a tooth-plate which in section might appear to represent partitions of supplementary chamberlets.

THE GENUS BEGIA SMOUT, 1956

The genus *Begia* was described by Smout (1956) from Iraq and Iran, from strata regarded by some authors as of late Cenomanian age and by others as of early Turonian age (according to Smout, 1956). This writer believes that the fauna accompanying *Begia* in Iran and Iraq points to a late Cenomanian age, in agreement with Henson, Reichel, and others (Smout, 1956). Specimens of *Begia* were also recorded by Smout from the lower Cenomanian at one locality in Iraq.

Begia was described in detail by Smout: It has a tooth-plate, and the granular calcareous, imperforate (but possibly originally perforate) walls are single-layered. The genus was placed by Smout in the Ceratobuliminidae because of the wall structure and general organization, including chamber arrangement, apertural characters and tooth-plate. A comparison of the figures and descriptions given by Omara (1956) and by Smout (1956) leaves little doubt concerning the identity of *Begia* and *Nezzazata*. The date of publication of *Begia* (December 12, 1956) makes it a junior synonym of *Nezzazata* Omara (published August 31, 1956). The wall structure and systematic position of *Nezzazata* will be discussed below.

NEZZAZATA FROM ISRAEL

Although specimens of *Nezzazata* have been observed at various localities in Israel, rich populations of this genus have been found hitherto at only two localities: in the Sinaf area, northwestern Negev, southern Israel ("Matsada" licence area, locality SB-122); and in the Beer-Ora region, southern Negev (section 3 of Braunfeld, in an unpublished report). At the first locality *Nezzazata* occurs abundantly in hard limestones with *Praealveolina* ex. gr. *cretacea*

(d'Archiac), *Cisalveolina?* sp., *Cribrostomoides* sp., miliolids, *Textularia* sp., and debris of Echinodermata (compare the fauna listed by Smout, 1956), underlying gypsiferous shales and limestones with the ammonites *Leoniceras* and *Thomasites*. The strata with *Nezzazata* are regarded by this writer to be of very late Cenomanian to earliest Turonian age, although a late Cenomanian age seems more probable. The overlying ammonite beds are of early Turonian age. Samples from the Beer-Ora region yielded abundant populations of well preserved and isolated specimens of *Nezzazata*. They originate from shales containing *Nerinea olisiponensis* and *Ostrea* sp., intercalated in a limestone complex underlying limestones and gypsiferous shales. The latter contain the ammonites *Leoniceras*, *Thomasites*, and *Choffaticeras*, and are of early Turonian age. The strata with *Nezzazata* are situated about 25 meters below the ammonite beds, and were regarded by this writer as of late Cenomanian age. According to A. Braunfeld (unpublished report), the *Nezzazata*-bearing strata should be correlated with strata which outcrop nearby and which contain *Heterodiadema*, *Holectypus* and *Exogyra*, characteristic upper Cenomanian forms.

The isolated specimens correspond to the figures given by Omara for *Nezzazata* and by Smout for *Begia*. All species of *Begia*, as described by Smout, are present in the same population, with the exception of the form described by Smout as *Begia calcarata*. The accompanying photomicrographs (pl. 1, figs. 1–14) of sectioned isolated specimens and of random thin sections demonstrate the great variability in general form of the specimens from Israel (compare also Smout, 1956), as well as the latter's identity with the forms described by Omara and by Smout. Until a statistical analysis of the form variation is carried out, all forms encountered in the material from Israel are referred to *Nezzazata simplex* Omara. Very small and rare specimens of *Nezzazata* were observed by this writer in limestones of Albian age from Galilee. They are also more high-spired than the specimens from the late Cenomanian of Israel. It appears that the genus *Nezzazata* is particularly characteristic of strata of very late Cenomanian age (possibly earliest Turonian) in the Middle East. The lower Cenomanian age attributed to the type strata of *Nezzazata* in Sinai may still need revision, especially in view of the occurrence of *Thomasinella*, which is characteristic of the upper Cenomanian of North Africa and which has been found hitherto only in the upper Cenomanian of Israel, as well as in view of the fact that no supporting evidence for the early Cenomanian age of the *Nezzazata*-bearing beds was given by Omara. A late Cenomanian age for these strata does not seem to be excluded.

SYSTEMATIC POSITION OF NEZZAZATA

Study of the wall-structure of specimens of *Nezzazata* from Israel reveals that the walls are single, non-lamellar, devoid of perforations and composed of granular calcite. Some specimens show a punctate pattern on the surface, as described by Smout in *Begia perforata*. In thin section such specimens show disseminated calcareous granules, darker and larger than the rest of the wall material and present in some specimens in all parts of the test walls, in others only in some parts of the latter. They seem to be due to recrystallization processes. In other specimens, small, irregularly spaced subspherical spaces, usually filled with limonitic matter, are present within the walls. They are also apparently due to alteration processes. Omara's figures are not convincing with regard to the presence of pores, and neither Smout nor this writer have found any traces of pores. It is believed that *Nezzazata* is imperforate. Its wall structure seems to be identical with that of *Valvulammina picardi* Henson, and can be adequately referred to as "microgranular" in the sense of Henson (1948).

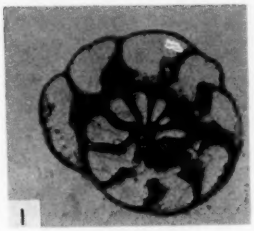
It will be shown elsewhere by this writer (Reiss, in press) that *Ceratobulimina* and its allies have walls that are distinctly perforated by fine and regular

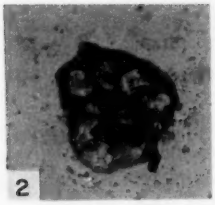
EXPLANATION OF PLATE 1

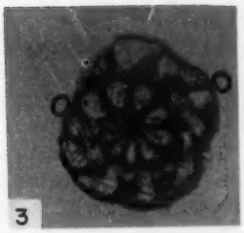
All figures × 55.

1–14 *Nezzazata simplex* Omara

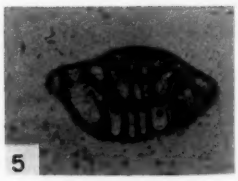
1–7, 9, no. 5463, late Cenomanian, Beer Ora: 1 (IT 30/66–10), 2 (IT 28/66–8), and 3 (IT 22/66–2), horizontal sections; 4 (IT 23/66–3), 5 (IT 26/66–6), 6 (IT 27/66–7), 7 (IT 24/66–4) and 9 (IT 29/66–9), vertical sections; 8, 10–14, no. 1265/1287, late Cenomanian (or earliest Turonian?), Sinaf, SB 122: 8 (67–25), 10 (67–27), 11 (67–23), 12 (67–26), 13 (67–26), and 14 (67–13), vertical and random sections from limestone; 10 and 11 are unusually large specimens.

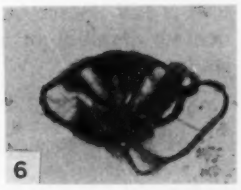

1

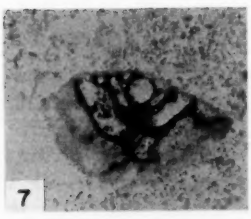

2


3

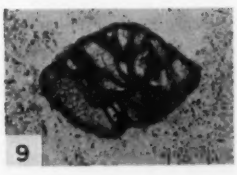
4


5


6

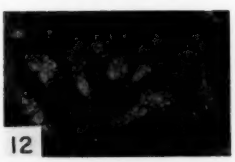

7

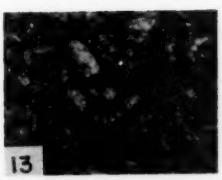
8


9

10

11


12


13

14

protopores. When the walls are studied under the polarizing microscope, they reveal the characters of the "radiate" group of foraminifera. Furthermore, it has been shown that the test of *Ceratobulimina* and its allies is constructed according to a lamellar pattern of growth, and has a distinctly laminated "secondary skeleton." The composition of the wall material of *Ceratobulimina* and its allies has been demonstrated by various authors to be aragonite. *Nezzazata*, therefore, has a completely different wall structure from *Ceratobulimina*, and cannot be included in the Ceratobuliminidae. It is perhaps best referred to the family Barkerinidae Smout. The position of the latter family within a larger taxonomic unit is still uncertain, and its relationship to other dentate families of foraminifera requires further study.

BIBLIOGRAPHY

HENSON, F. R. S.

1948 – *Larger imperforate foraminifera of south-western Asia.* London: British Museum (Natural History), pp. v–xi, 1–127, pls. 1–16, text-figs. 1–16.

OMARA, S.

1956 – *New foraminifera from the Cenomanian of Sinai, Egypt.* Jour. Pal., vol. 30, no. 4, pp. 883–890, pls. 101–102, text-figs. 1–6.

REISS, Z.

[MS.] *Classification of lamellar foraminifera.* Micropaleontology (in press).

SMOUT, A. H.

1956 – *Three new Cretaceous genera of foraminifera related to the Ceratobuliminidae.* Micropaleontology, vol. 2, no. 4, pp. 335–348, pls. 1–2, text-figs. 1–2.

ABSTRACT: *Thirty-five papers on microfossils other than foraminifera and ostracodes are listed. A brief analysis, including names of new taxa, is given for each entry.*

Annotated bibliography of micropaleontology in France, 1952–1956 (exclusive of foraminifera and Ostracoda)

GEORGES DEFLANDRE
Laboratoire de Micropaléontologie
École Pratique des Hautes Études
Paris

For a number of years, the activities of the Laboratoire de Micropaléontologie de l'École Pratique des Hautes Études in Paris have not been reviewed in "The Micropaleontologist" nor in "Micropaleontology." The titles of the publications of this laboratory have not appeared in these periodicals. It is partially the object of the present paper to remedy this fact.

Because papers on foraminifera and Ostracoda published in France have generally been cited in preceding numbers of "Micropaleontology," I will give here only those dealing with other groups. Following the example set by Heinrich Hiltermann in his "Annotated bibliography of micropaleontology in Germany for 1955" (1956, Micropaleontology, vol. 2, no. 4, pp. 385–392), a brief analysis of each paper will be given, including lists of the new taxa.

BRAARUD, T., DEFLANDRE, G., HALLDAL, P., AND KAMPTNER, E.

1954 – *Terminologie, nomenclature et systématique chez les coccolithophoridés.* Congr. Internat. Bot., 8th, Paris, C.R., sec. 17, pp. 69–70.

Coccoliths are classified into three major groups based upon the nature and arrangement of the skeletal elements as revealed by the electron microscope. Necessary revisions in the taxonomy and nomenclature of the coccolithophorids are made. List of recent publications given. (See the English translation of this paper in "Micropaleontology," vol. 1, no. 2, pp. 157–159.)

DEFLANDRE, G.

1952 – *Albaillella nov. gen., radiolaire fossile du Carbonifère inférieur, type d'une lignée aberrante éteinte.* Acad. Sci., C.R., vol. 234, pp. 872–874, 9 text-figs.

This remarkable new type of radiolarian possesses a conical shell, not perforated but thin and lamellose, composed of a skeletal element which is partly internal and partly external. *Albaillella* n. gen. (with *A. paradoxa*, *A. undulata*, *A. cornuta*, and *A. gibbosa*, n. sp.) is the type of a new family, Albaillellidae. This family belongs to a new order, Albaillellidea, proposed later by the author in a short note (DEFLANDRE, 1953, *Titres et travaux scientifiques, Supplément 1949–1953*, p. 14).

1952 – *Classes des xanthomonadines, des ébriédiens, des silicoflagellidés, des coccolithophoridés; Flagellés fossiles, etc.* In: GRASSÉ, P. P., *Traité de Zoologie.* Vol. 1, fasc. 1, pp. 207–209, 212–226, 283–284, 391–470, 560–573, 91 text-figs.

A broad and exhaustive review of our knowledge of the fossil flagellates, including Dinoflagellata and Chrysomonadina. The chapter on the Coccolithophoridae possesses the character of an original memoir, revising the classification and establishing the following new taxa: *Sphaerocalyptra* n. gen., *Anacanthoica* n. gen., Anthosphaerinae n. subfam., Halopappinae n. subfam., *Homozygosphaera* n. gen., *Anoplosolenia* n. gen., *Rhabdolithus perlongus* n. sp., *Parhabdolithus* n. gen., *Parhabdolithus liasicus* n. sp., *Cribrosphaerella* n. gen., *Discoaster mirus* n. sp., Sphenolithidae n. fam., *Sphenolithus* n. gen., *Sphenolithus radians* n. sp., *Peritrachelina* n. gen., and *Peritrachelina ornata* n. sp.

1953 – *Superclasse des Rhizopodes: Généralités; Ordres des Aconchulina, des Athalamia, des thécamoebiens; Superclasse des actinopodes; Radiolaires et héliozoaires fossiles.* In: GRASSÉ, P. P., *Traité de Zoologie.* Vol. 1, fasc. 2, pp. 3–4, 92–148, 267–268, 295–332, 487, 1 pl. col., 81 text-figs.

The most important of these chapters from the viewpoint of the micropaleontologist is the one concerning the fossil Radiolaria. It gives a clear and objective analysis of the present state of our knowledge. It does not present a new classification, but it offers the basis upon which a new classification can be built. A large body of data is critically reviewed, and errors contained in some recent papers are pointed out. The evolution (and phylogeny) of the fossil Radiolaria and, especially, the comparative evolution of the Sphaerellaria and Nassellaria, are indicated. Three aberrant types from Visean phosphorites, *Albaillella*, *Palaeoscenidium* and *Ceratoikiscum*, show that the study of the Radiolaria of the Paleozoic sheds new light on the general classification and the evolutionary trends of the group. New taxa are: *Palaeoscenidium* n. gen., *Palaeoscenidium cladophorum* n. sp., *Ceratoikiscum* n. gen., *Ceratoikiscum avimexpectans* n. sp., *Centrolonche obscura* n. sp., *Dorylonchidium antiquum* n. sp., *Amphisphaera heteropyxis* n. sp., Lithapinae n. subfam., Saturnalinae n. subfam., Cenosphaeridae n. fam., *Drepotadium* n. gen., *Drepotadium ambiguum* n. sp., *Cantharospyris oamaruensis* n. sp., and *Patagospyris gaudfernaui* n. sp.

1953 – *Hétérogénéité intrinsèque et pluralité des éléments dans les coccolithes actuels et fossiles.* Acad. Sci., C. R., vol. 237, pp. 1785–1787, 7 text-figs.

Radial and parallel arrangement of the calcite particles coexisting in the sphenolith of *Sphenolithus heteromorphus* n. sp. Helicoidal disposition of the calcite in the staff of the rhabdolith in *Rhabdolithus splendens* n. sp. Plurality of the constituent elements in many apparently homogeneous discoliths shown by electron micrographs.

1954 – *Systématique des hystrichosphaeridés: Sur l'acception du genre Cymatiosphaera O. Wetzl.* Soc. Géol. France, C. R. Somm., no. 12, pp. 257–258.

Emendation of the genus; genotype designated: *Cymatiosphaera radiata* O. Wetzel, 1933. *Cymatiosphaera deanei*, n. sp., and *Cymatiosphaera wetzeli*, n. sp., described. A number of species previously classified in various genera (*Dictyospyris*, *Xanthidium*, *Micrhystridium*) assigned to *Cymatiosphaera* emend., which is placed in the family Pterospermopsidae Eisenack (Order Hystrichosphaeridea Eisenack), near *Membranilarnax* O. Wetzel.

1954 – *Premiers apports de la paléontologie à nos connaissances sur l'évolution des coccolithophoridés.* Congr. Internat. Bot., 8th, Paris, C. R., Sect. 17, pp. 119–120.

The study of fossil Coccolithophoridae produces important and basic data concerning the evolution of this class of calcareous flagellates. A good example is given by the existence in Jurassic strata of remarkable complex types, such as *Parhabdolithus* or other rhabdolithoid forms, which combine the characters of a trumpet-like rhabdolith with those of a typical placolith (*Rhabdolithus patulus*).

1955 – *Palaeocryptidium n.g. cayeuxi n.sp.; microorganismes incertae sedis des phtanites briovériens bretons.* Soc. Géol. France, C. R. Somm., no. 9–10, pp. 182–184.

A new genus is established for some very small micro-organisms from the pre-Cambrian phtanite of Brittany. For a long period, they have erroneously been considered to be Radiolaria, following the ideas of L. Cayeux. Actually, these microfossils are not mineralized; they are preserved in a state of more or less carbonaceous organic matter. The type, *Palaeocryptidium cayeuxi*, is not taken from the older publication by Cayeux, but from the Fichier Micropaléontologique, Série 8, Fiche 1182, which gives a drawing and a photomicrograph from an original slide of Cayeux in the Galerie de Paléontologie du Muséum National d'Histoire Naturelle de Paris, numbered 26. *Palaeocryptidium* is classified as incertae sedis near the Leiosphaeridae, Order Hystrichosphaeridea.

DEFLANDRE, G., AND COOKSON, I. C.

1954 – *Sur le microplancton fossile conservé dans diverses roches sédimentaires australiennes s'étageant du Crétacé inférieur au Miocène supérieur.* Acad. Sci., C. R., vol. 239, pp. 1235–1238, 17 text-figs.

Preliminary note on the fossil microplankton from Australian sediments, giving general data and illustrations of a number of new forms belonging to the Dinoflagellata, Hystrichosphaeridea and other groups.

1955 – *Fossil microplankton from Australian late Mesozoic and Tertiary sediments.* Australian Jour. Marine and Freshwater Research, vol. 6, no. 2, pp. 242–313, 9 pls., 58 text-figs.

First comprehensive account of fossil microplankton assemblages from the Southern Hemisphere. Dinoflagellates, hystrichospherids and micro-organisms of uncertain affinity, all of which have unmineralized membranes or shells, are classified. Twenty-five genera, of which four are new (*Eisenackia*, *Cyclonephelium*, *Nematosphaeropsis*, and *Schematophora*), and seventy-five species, of which forty-six are new, are recorded from Cretaceous and Tertiary deposits. The data obtained provide indications concerning the age of

certain portions of two bores. A number of interesting facts arise from comparisons with the fossil microplankton of European sediments.

DEFLANDRE, G., AND DEFLANDRE-RIGAUD, M.

1949 – *Ciliés (infusoires); Tintinnoidea (incl. Calpionella auctorum) et Ciliatae incertae.* Fichier Micropal., ser. 9., Arch. Orig.Centre Doc. C.N.R.S., no. 302, Fiches I–VI et 1186–1293.

This card index, which is distributed in the form of standard microfilm, contains figures of all the published fossil ciliates, especially of the Tintinnoidea or Tintinnina. New forms are: *Parafavelloides* n. gen., *Parafavelloides rüsti* n. sp., *Parafavelloides elongata* n. sp., *Parafavelloides ventricosa* n. sp., and *Calpionella cadischi* n. sp. This card index was recorded in "The Micropaleontologist" (1950, vol. 4, no. 3, p. 10), but the new taxa have been overlooked in recent works on the subject.

1956 – *Micrascidites manip. nov., sclérites de didemnidés (ascidies, tuniciers) fossiles du Lutétien du Bassin parisien et du Balcombien d'Australie.* Soc. Géol. France, C. R. Somm., no. 4, pp. 47–48, 5 text-figs.

Numerous sclerites of ascidians, morphologically identical with those found in the tests of living Didemnidae, have been found in the Upper Miocene of Australia and identified in other strata, e.g., the Lutetian near Paris. They are described under the names *Micrascidites* n. manip. or n. gen., and *Micrascidites vulgaris* n. cent. or n. sp.

DEFLANDRE, G., AND FERT, C.

1952 – *Sur la structure fine de quelques coccolithes fossiles observés au microscope électronique; Signification morphogénétique et application à la systématique.* Acad. Sci., C. R., vol. 234, pp. 2100–2102, 8 text-figs.

First electron photomicrographs of fossil coccoliths, providing new data for use in identification, and modifying ideas in the field of systematics. New forms are: *Discolithus dupouyi, D. oculus-electrae, D. spinosus, D. crux, Cyclolithus imbricatus,* and *Calcidiscus obscurus,* all from the Lutetian marl of Donzacq, Landes.

1953 – *Études des coccolithophoridés des vases actuelles au microscope électronique; Orientation des particules élémentaires de calcaire en rapport avec les notions d'Heliolithae et d'Ortholithae.* Acad. Sci., C. R., vol. 236, pp. 328–330, 9 text-figs.

Existence of different types of structure demonstrated by radial coccoliths, and first discovery of parallel-lying fine strips or lamellae of calcite in the small, rhomboidal, boat-like coccoliths of the Calciosolenidae.

1953 – *Application du microscope électronique à l'étude des coccolithophoridés; Technique et résultats liminaires.* Soc. Hist. Nat. Toulouse, Bull., vol. 88, pp. 301–313, 4 pls.

Methods and techniques in the study of Coccolithophoridae with the electron microscope. Brief account of the results obtained. First stereoscopic electron photomicrograph of one coccolith of *Coccolithus huxleyi.*

1954 – *Observations sur les Coccolithophoridés actuels et fossiles en microscopie ordinaire et électronique.* Ann. Pal., vol. 40, pp. 115–176, 15 pls., 127 text-figs.

The first chapter, by Deflandre and Fert, presents a group of new data on the organization and the ultrastructure of the coccoliths, both Recent and fossil, based upon studies with the electron microscope together with the results of examination in polarized light. In the second chapter (by Deflandre only) numerous new forms are described, followed by paleontological discussion.

The following new species, based on electromicrographs only, are described under the joint authorship of Deflandre and Fert (no types for these new species can be preserved): *Discolithus parvidentatus, D. surirella* (Cretaceous); *Cyclolithus imbricatus, Discolithus alimaniensis, D. dictyodes, D. simillimus, Tremalithus parvulus* (Tertiary); *Gephyrocapsa kamptneri,* and *Rhabdolithus xiphos* (Recent). The following new species studied by ordinary microscopy, whose types are recorded in strew slides, are established by Deflandre only: *Discolithus cancer, D. crassus, Mitrolithus* n. gen., *Mitrolithus elegans* n. sp., *Parhabdolithus marthae, Rhabdolithus annulatus, R. clavatus, R. imbut, R. inconspicuus, R. patulus, R. superbus; Stephanolithion speciosum; Zygolithus erectus, Pyxolithus* n. gen., *Pyxolithus problematicus* n. sp. (Jurassic); *Discoaster(?) furcatus, Discolithus ponticulus, Rhabdolithus intercisus, R. striatus, Zygolithus turriseiffeli* (Cretaceous); *Calyptrolithus morionum, Clathrolithus* n. gen., *Clathrolithus ellipticus* n. sp., *Discolithus cocconeis, D. lineatus, D. macroporus, D. oamaruensis, D. obliquipons, D. panarium, D. pulcher, D. radiatus, D. solidus, D. tectus; Isthmolithus* n. gen., *Isthmolithus recurvus* n. sp.; *Micrantholithus bramlettei; Polycladolithus* n. gen., *Polycladolithus operosus* n. sp.; *Rhabdolithus costatus, R. creber, R. pinguis, R. rectus, R. scabrosus, R. vitreus; Scapholithus* n. gen., *Scapholithus fossilis* n. sp.; *Tremalithus oamaruensis, Zygolithus bijugatus, Z. diplogrammus, Z. dubius,* and *Z. tenansa* (Tertiary).

DEFLANDRE-RIGAUD, M.

1952 – *Contribution à la systématique des sclérites d'holothurides fossiles.* Monaco, Inst. Océanogr., Bull., no. 1012, pp. 1–12.

Discussion of the systematic value of holothurian sclerites; distribution of the various forms among the orders of Holothurida. Possibilities of classifying sclerites within the general classification, retaining the morphological classification proposed by Croneis. New manipuli (or genera) are established: *Binoculites*, *Staurocumites*, *Mortensenites*, and *Rhabdotites*. *Protocaudina* Croneis and *Palaeochiridota* Croneis are emended.

1953 – *Classes des holothurides.* In: PIVETEAU, J., *Traité de Paléontologie.* Vol. 3, pp. 948–957, 31 text-figs.

General description. Discussion of macroscopic remains. Brief diagnoses of the eighteen genera (or manipuli) of fossil sclerites, all figured.

1954 – *Microfossiles des silex sénoniens du Bassin de Paris.* Soc. Géol. France, C. R. Somm., no. 3, pp. 58–59, 3 text-figs.

Chert and chalk from the upper part of the Craie de Meudon (Maestrichtian). First record of *Braarudosphaera bigelowi* (Gran and Braarud) Deflandre in the Paris Basin. List of microfossils found in the chert: Dinoflagellates (*Gymnodinium hexagonum* n. sp.), Flagellata incertae sedis (four species of *Palaeostomocystis*), hystrichospherids (nine species), and microfossils incertae sedis (*Ceratocystidiopsis incerta* n. sp.).

1955 – *Microfossiles des silex sénonien du Tréport (Seine-Maritime).* Soc. Géol. France, C. R. Somm., no. 1, pp. 19–21.

Presence of silicified coccoliths and foraminifera in the cortex of one flint nodule. List of species, including the rare forms *Palaeoperidinium velatum* Conrad, *Ceratocorys veligera* (Deflandre) Lejeune-Carpentier (both dinoflagellates), and *Hystrichosphaera cingulata* (O. Wetzel) Deflandre.

1955 – *Sur les sclérites d'alcyonaires fossiles et leur classification.* Acad. Sci., C. R., vol. 241, pp. 1327–1329, 16 text-figs.

Numerous specimens of alcyonarian sclerites were found in the Middle Miocene (Balcombian) of Balcombe Bay, Victoria, Australia. Various types are classified in the new manipulus (or genus) *Micralcyonarites*, with *M. vulgaris*, *M. fusticulus*, *M. fusunculus*, *M. scopula*, *M. perverrucosus*, *M. alloiteaui*, *M. clava*, *M. laminosus*, *M. hystrix*, *M. corallioides*, *M. verticillatus*, *M. pedigerus*, *M. speciosus*, *M. tripes*, *M. cornutitergum* and *M. gallicus*, all centuriae novae or n. sp.

1956 – *Les sclérites d'alcyonaires fossiles; Éléments d'une classification.* Ann. Pal., vol. 42, pp. 1–24, 4 pls., 1 text-fig.

Brief review of the data on this neglected group of microfossils. Characters of alcyonarian sclerites, which are composed of fibrous calcite. Various types of fossil sclerites. In the systematic part, descriptions of species (partly named in a previous paper) are given, including comparisons with sclerites of living species. A number of new forms are added: *Micralcyonarites robustus*, *M. undatus*, and *M. conjunctus*. All are from the Balcombian of Australia. *Micralcyonarites gallicus* is from the Lutetian of France. *Nephthya cretacea* Počta, from the Upper Cretaceous of Bohemia, is reclassified under the name *Micralcyonarites cretaceus*. A short additional chapter gives the description of a new calcareous microfossil, *Neanthozoites* n. manip. or n. gen., with three species (or centuriae): *Neanthozoites elegans* (Eocene and Miocene), *N. fibratus* (Miocene) and *N. arachnoidiscus* (Miocene). They are considered as representing juvenile stages of Anthozoa, apparently of the suborder Fungiida (Madreporia). The majority of the species are illustrated by photomicrographs taken in ordinary and in polarized light.

DEUNFF, J.

1951 – *Sur la présence de microorganismes (hystrichosphères) dans les schistes ordoviciens du Finistère.* Acad. Sci., C. R., vol. 233, pp. 321–323, 6 text-figs.

First record of hystrichospherids in the Ordovician of Brittany. New forms are *Hystrichosphaeridium trisulcum* and *H. monacanthum*.

1954 – *Sur le microplancton du Gothlandien armoricain.* Soc. Géol. France, C. R. Somm., no. 3, pp. 54–55.

Record of *Micrhystridium*, *Hystrichosphaeridium brevispinosum* Eisenack var. *nanum* Deflandre, and especially *H. castaneum* Eisenack in the Armorican Gotlandian.

1954 – *Microorganismes planctoniques (hystrichosphères) dans le Dévonien du Massif armoricain.* Soc. Géol. France, C. R. Somm., no. 11, pp. 239–242, 8 text-figs.

First record of hystrichospherids in the Devonian of Brittany; two new species are described: *Hystrichosphaeridium lewisi* and *Micrhystridium nebulosum*.

1954 – *Sur un microplancton du Dévonien du Canada recèlant des types nouveaux d'hystrichosphaeridés.* Acad. Sci., C. R., vol. 239, pp. 1065–1066, 10 text-figs.

Three new genera, *Polyedryxium*, *Veryhachium*, and *Anthatractus* (hystrichospherids), and a number of species of *Cymatiosphaera* and *Micrhystridium* are found in fine calcareous mud contained in a silicified *Favosites* (coral) from the Onondaga formation, Devonian, of Ontario, Canada. New taxa: *Polyedryxium tectum, P. bathyaster, P. diabolicum, P. deflandrei, P. pharaonis; Veryhachium eisenacki, V. tetraëdron, V. mamillatum, V. asymmetricum; Micrhystridium pauci-spinum, M. sericum; Cymatiosphaera cubus, C. fagoni, C. prismatica, C. canadensis; Anthratractus insolitus.*

1954 – *Veryhachium, genre nouveau d'hystrichosphères du Primaire.* Soc. Géol. France, C. R. Somm., no. 13, pp. 305–306.

Diagnosis of the new genus; type: *Veryhachium trisulcum* (*Hystrichosphaeridium trisulcum* Deflandre, 1951); Ordovician of Finistère, France.

1955 – *Aremoricanium, genre nouveau d'hystrichosphères du Silurien breton.* Soc. Géol. France, C. R. Somm., no. 11–12, pp. 227–229, 3 text-figs.

A new type of hystrichospherid with two concentric shells, the internal one having a polar perforation, the external one provided with spines and a polar conical expansion. Type: *Aremoricanium rigaudae.* Ordovician, Finistère, France.

1955 – *Un microplancton fossile dévonien à hystrichosphères du Continent nord-américain.* Bull. Micr. Appl. Paris, ser. 2, vol. 5, pp. 138–149, 4 pls., 28 text-figs.

Preliminary paper on the microplankton preserved in remarkably good condition in a Devonian coral from Canada (Onondaga formation, Decew, Ontario). New species and varieties are added to those formerly named: *Hystrichosphaeridium spiciferum, H. ramusculosum* Deflandre var. *macrocladum, Veryhachium furcillatum, V. heterogonum, V. ambiguum, V. remotum, V. crucistellatum, V. exasperatum, Polyedryxium decorum, P. simplex, P. evolutum, P. pruvosti, P. piveteaui, P. venustum, P. cuboides, P. centrigerum, P. deflandrei* var. *major, Cymatiosphaera cornifera, C. multisepta, Micrhystridium alloiteaui, Pterospermopsis onondagaensis, Leiofusa bacillum,* and *L. minuta.*

FIRTION, F.

1953 – *Le Cénomanien inférieur du Nouvion-en-Thiérache: examen micropaléontologique.* Soc. Géol. Nord, Ann., vol. 72, pp. 150–164, 3 pls., 1 text-fig.

Study of the fossil microplankton, pollen, and spores provides indications concerning the age of two borings. Description and figures of a number of species. New taxa are: *Hystrichosphaeridium longifurcatum* and *Micrhystridium singulare.*

VALENSI, L.

1953 – *Microfossiles des silex du Jurassique moyen; Remarques pétrographiques.* Soc. Géol. France, Mém., no. 68, pp. 1–100, 16 pls.

This thesis is the first large-scale account of the fossil microplankton preserved in the flints of the Middle Jurassic of France. It gives data on the relative and absolute abundance of the microfossils of the flints, and describes all the forms encountered, which are well illustrated by good drawings and photomicrographs. The new taxa belong to the dinoflagellates (*Gonyaulax cornigerum, Palaeoperidinium reticulatum*) and the hystrichospherids (*Hystrichosphaeridium deflandrei, H. pattei,* and thirteen new species of the genus *Micrhystridium,* which is the most representative genus in these flints).

1954 – *Sur les silex oolithiques de la Celle-Bruère (Cher).* Soc. Géol. France, C. R. Somm., no. 4, pp. 80–82.

Numerous oolites and sponge spicules were found in the interstitial cement, but no microorganisms.

1954 – *Confirmation de l'âge jurassique moyen des silex de la région de Bressuire (D.-S.).* Ann. Univ., ser. 2, no. 5, Act. 73e Congr. A.F.A.S., Poitiers, p. 295.

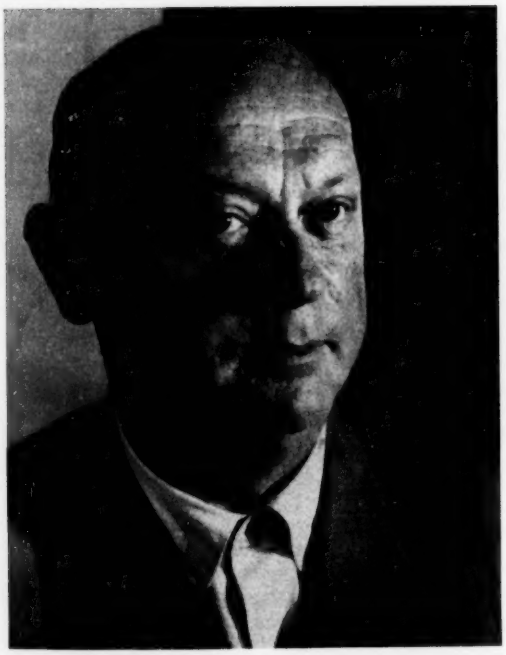
The hystrichospherids and especially many species of *Micrhystridium* confirm the age (Toarcian to Bathonian) of the black flints of this region.

1955 – *Sur quelques microorganismes des silex crétacés du Magdalénien de Saint-Amand (Cher).* Soc. Géol. France, Bull., ser. 6, vol. 5, pp. 35–40, 7 text-figs.

Description of rare or new forms of hystrichospherids from reworked flints (Magdalenian, near Saint-Amand): *Hystrichosphaeridium rhopalophorum, H. tridactylites, H. huguonioti,* and *Micrhystridium fucosum.*

1955 – *Étude micropaléontologique des silex du magdalénien de Saint-Amand (Cher).* Soc. Préhist. Franç., Bull., vol. 52, no. 9–10, pp. 584–596, 5 pls.

The age and, perhaps, the origin of the Magdalenian flint implements from the neighborhood of St. Amand can be determined on the basis of the microfossil content. Some of these flints are Jurassic in age, others are Cretaceous, and one is Tertiary. Photomicrographs of numerous forms are given. New taxa are: *Membranilarnax amandopolitanum* and *Hystrichosphaeridium rhabdophorum.*



Carl A. Wicher – 1901-1957

Micropaleontology, especially the study of Triassic and Jurassic microfaunas and Cretaceous foraminifera and their applications in worldwide stratigraphy, suffered a great loss in the premature passing of Professor Dr. Carl A. Wicher, who died in Hannover, Germany, on April 3, 1957. Dr. Wicher was born on May 11, 1901, in Schoppinitz, Silesia. He attended the Technical University of Berlin-Charlottenburg, where he studied mining science. After engaging in practical work in the coal mines of Upper Silesia, he worked as a geologist and geophysicist in Australia and Rumania.

From 1930 to 1932, he continued his scientific education with the study of cryptogamic botany, working as assistant to Professor Robert Potonié. He graduated with the publication of an important paper, "Sporenformen der Flammkohle des Ruhrgebietes." After graduation, he obtained a position with the Preußische Geologische Landesanstalt in Berlin, and during the next thirteen years, until the end of World War II, he was engaged in micropaleontological and stratigraphic exploration work, especially in connection with the drilling program of the Northwest German petroleum industry.

Dr. Wicher was one of the earliest German pioneers in practical micropaleontology and stratigraphic correlation by means of foraminifera and ostracodes, and he amassed more than 60,000 slides during a period of twelve years (1932 to 1944). Shortly before he left Berlin, he was employing ten graduates or technicians in his laboratory. The results of his extremely exact determinations of foraminiferal assemblages were presented in a series of stratigraphic publications that were concerned especially with the Triassic, Liassic, Wealden, and Upper Cretaceous. He also published an excellent laboratory manual, "Praktikum der angewandten Mikropaläontologie" (1942), which was a compilation of his laboratory experiences.

World War II put an end to Wicher's plans for further development of his laboratory and its exploration methods. After the end of the war, Wicher left Germany to establish modern micropaleontological research methods in Yugoslavia. As a result of the success he achieved in his stratigraphic investigations of late Tertiary strata, Wicher graduated as Professor and was elected a member of the Serbian Academy of Sciences. Because of failing health, Wicher returned to Germany in 1950. He obtained a position as micropaleontologist with the Preußische Bergwerks- und Hütten-Aktiengesellschaft, a German state oil company, at Hannover.

Dr. Wicher died at Hannover at the age of fifty-six on April 3, 1957, after a brief illness. He was highly respected and esteemed by all who knew him, especially by his co-workers and other micropaleontologists. We regret that he was taken from us so early, before he was able to accomplish all of the important work he had planned.

HELMUT BARTENSTEIN
Mobil Oil A.G. in Deutschland
Celle, Germany

ABSTRACT: *Six species of* Gomphocythere *are known from the Jurassic-Cretaceous passage beds in northwestern Germany and England. They are here reduced to two species, with six subspecies. Problems concerning the taxionomy of brackish-water Ostracoda are also discussed.*

Die Gattung Gomphocythere in Nordwestdeutschland und das Problem der brackischen Ostracoden

C. A. WICHER
Preussische Bergwerks- und Hütten-Aktiengesellschaft
Hannover, Germany

[EDITORS' NOTE: *Professor Wicher died while his paper on* Gomphocythere *was in press. The memorial on the facing page was received on June 28, 1957.*]

GOMPHOCYTHERE IN NORDWESTDEUTSCHLAND

Martin stellte 1940 die "Arten" *striata*, *silvana*, *pahasapensis* und *berwickensis* zur Gattung *Gomphocythere*. Auf S. 340 schreibt er dazu: "Wir lassen es dahingestellt, ob nicht vielleicht noch weitere, bisher der Gattung *Metacypris* zugerechnete fossile Formen besser zu *Gomphocythere* zu stellen wären." Nun sind aus Nordwestdeutschland noch *Metacypris forbesii* Jones und *Metacypris planiverrucosa* Klingler bekannt. Nach eingehendem Studium muß ich auch diese beiden Formen zur Gattung *Gomphocythere* stellen.

Bei den ersten vier Formen ist das Bild relativ einfach. Sie tauchen in Nordwestdeutschland zum Teil nur ein bis zwei Proben auf, haben in der Zwischenzeit aber anderswo weitergelebt. Als erste erscheint bei uns *planiverrucosa* im Unter-Kimmeridge; die zweite ist *forbesii* im Serpulit (in England = Mittel-Purbeck); die dritte ist *striata* im Wealden 1 (in England = Kopf des Mittel-Purbeck); die vierte ist *silvana* im Wealden 3 etwa Mitte (in England = Kopf des Ober-Purbeck); die fünfte ist *fittoni* im Wealden 4 (in England = Weald clay); die sechste ist *berwickensis* im Wealden 4 (in England = Weald clay).

Die beiden letzten Formen komplizieren das Bild insofern, als man an sich erwarten müßte, daß die schwach skulptierten Formen (*fittoni*) eher einsetzen als die grob skulptierten (*berwickensis*). Das ist manchmal der Fall, zum Beispiel in der Bohrung Lingen 1, wo *fittoni* bei 1321–1324 meter und *berwickensis* bei 1307–1309 meter gefunden wurden.

In anderen Bohrungen war teilweise das Gegenteil der Fall. Man darf nicht vergessen, daß die Grobskulptur – zumindest teilweise – auf exogene Einflüsse zurückgeführt werden muß. Ebenso ist nicht zu vergessen, daß Namen, wie zum Beispiel "*striata*" an sich fehl am Platz sind, denn wie meine Abbildungen zeigen, sind alle nordwestdeutschen Gomphocytheren mehr oder weniger "striat." Was aber beim Studium der nordwestdeutschen Gattung *Gomphocythere* auffällt, ist die Tatsache, daß die Männchen auf Änderungen der Umwelteinflüsse früher reagieren als die Weibchen, siehe zum Beispiel die nodosen Formen. Ferner ist es eine Tatsache, daß ein Teil der männlichen Formen geflügelt ist.

Diese beiden Beobachtungen veranlaßten mich, die in Nordwestdeutschland vorhandenen sechs *Gomphocythere*-Arten auf zwei Arten zu reduzieren, nämlich auf *Gomphocythere forbesii* und *Gomphocythere fittoni* und die schon bestehenden Namen für Unterarten zu verwenden. Anschließend führe ich die Unterarten einzeln auf, gebe jedoch nur notwendige Ergänzungen zu den vorhandenen Diagnosen anderer Autoren.

SYSTEMATISCHE BESCHREIBUNGEN

Gattung GOMPHOCYTHERE Sars, 1924

Gomphocythere forbesii (Jones) subsp. **planiverrucosa** (Klingler)
Tafel 1, Figuren 1a–c, 2a–c

Metacypris planiverrucosa KLINGLER, 1955, Geol. Jahrb., Bd. 70, S. 206, Taf. 12, Fig. 17a; Taf. 13, Fig. 17b–d.

Bei den Männchen deutliche Flügelansätze etwa in der Mitte nahe dem Ventralrand. Bei den Weibchen habe ich die Flügelansätze, die Klingler angibt, nie gesehen!

Die von Klingler erwähnten feinen Warzen sind bei allen *Gomphocythere*-Arten mehr oder weniger deutlich vorhanden.

Gomphocythere forbesii (Jones) subsp. **forbesii** (Jones)
Tafel 1, Figur 3, 3a–c

Metacypris forbesii Jones, 1885, Geol. Soc. London, Quart. Jour., vol. 41, S. 345, Taf. 8, Fig. 13, 15, 16. – Jones, 1886, Geol. Mag., new ser., dec. 3, vol. 3, no. 4, S. 146, Taf. 4, Fig. 1a–c. – Martin, 1940, Senckenbergiana, Bd. 22, Nr. 5/6, S. 336, Taf. 6, Fig. 89–94.

Leider habe ich bisher bei den vielen Proben, die ich aus dem Serpulit mikroskopiert habe, noch nie ein Männchen gesehen, zweifle aber keinen Augenblick daran, daß sich dieses Männchen zwanglos in die hier aufgeführte *Gomphocythere*-Reihe einordnen läßt. Auch das bei Martin (1940, Taf. 6, Fig. 89–90) abgebildete Exemplar macht mir nicht den Eindruck eines Männchens, sondern sieht eher wie eine Jugendform eines Weibchens aus. Theoretisch müßten hier die Flügel schon wesentlich besser entwickelt sein, als zum Beispiel bei *Gomphocythere forbesii planiverrucosa*. Das Weibchen von *Gomphocythere forbesii forbesii* ist die am distalen Ende aufgeblähteste aller nordwestdeutschen *Gomphocythere*-Arten. Ich besitze das Foto eines noch stärker aufgeblähten Weibchens aus meiner Berliner Zeit. Dieses stammt aus etwa gleich alten Schichten von Tendaguru, Skelett S, Afrika. Das Original ging mir leider während des Krieges verloren.

Gomphocythere forbesii (Jones) subsp. **striata** Martin
Tafel 1, Figuren 4a–c, 5a–c

Gomphocythere striata Martin, 1940, Senckenbergiana, Bd. 22, Nr. 5/6, S. 342, Taf. 7, Fig. 101–104; Taf. 12, Fig. 174.

Die Flügel beginnen zuerst als stärkere Leisten und erst im letzten Viertel enden sie als Dorn. Nach meinem Material sind nur die Männchen geflügelt (siehe Fig. 4 und 5). Daher muß ich annehmen, daß die als Weibchen von Martin (1940, Taf. 7, Fig. 101–104) abgebildeten Formen in Wirklichkeit Männchen sind.

Gomphocythere forbesii (Jones) subsp. **silvana** Martin
Tafel 1, Figur 6a–c; Tafel 2, Figur 1a–c

Gomphocythere silvana Martin, 1940, Senckenbergiana, Bd. 22, Nr. 5/6, S. 345, Taf. 6, Fig. 87–88; Taf. 9, Fig. 144–147; Taf. 12, Fig. 175.

Auch von dieser Form bildet Martin (1940) nur Männchen ab. Daher gilt die Angabe von Martin "ventral befindet sich auf jeder Klappe ein leistenartiger Vorsprung, welcher hinten in einem charakteristischen Dorn endet" nur für die Männchen. Bei den Weibchen fehlt dieser Dorn. Dafür haben die Weibchen, wie Wolburg (1949, S. 352) schreibt, hinten sackartig erweiterte hintere Ecken an beiden Klappen, wie meine Fig. 7 zeigt. Allerdings kenne ich weibliche Exemplare von *silvana*, wo diese sackartige Erweiterung fehlt und wo die Weibchen nur normal in üblicher Weise hinten aufgebläht sind.

Gomphocythere fittoni (Mantell) subsp. **fittoni** (Mantell)
Tafel 2, Figuren 2a–c, 3a–c

Metacypris fittoni (Mantell). – Jones, 1888, Geol. Mag., new ser., dec. 3, vol. 5, S. 539.

Gomphocythere pahasapensis (Roth). – Martin, 1940, Senckenbergiana, Bd. 22, Nr. 5/6, S. 340, Taf. 6, Fig. 95–97; Taf. 7, Fig. 98–100.

Männchen einen Knoten vor den sulci, hinten fünf Knoten. Weibchen keine oder bis zu sechs relativ schwachen Knoten. Ich stelle diese Form besser zu der aus dem englischen Weald clay bekannten *fittoni* als zur nordamerikanischen *pahasapensis*, da auch sonst die Ostracodenführung in England die gleiche ist wie in Nordwestdeutschland. Bei dieser Form merkt man besonders deutlich, daß die Skulptur der Männchen sich eher entwickelt als die der Weibchen.

Gomphocythere fittoni (Mantell) subsp. **berwickensis** Martin
Tafel 2, Figuren 4a–c, 5a–c

Gomphocythere berwickensis Martin, 1940, Senckenbergiana, Bd. 22, Nr. 5/6, S. 344, Taf. 12, Fig. 176–181; Text-Fig. 1–2.

Aus dem höchsten Weald clay von Sandown Bay, England, besitze ich eine Probe, aus der eindeutig hervorgeht, daß die Feinskulptur bei dieser Form vorhanden sein kann oder fast ganz zurücktreten kann. Selbst Martin (1940) schreibt auf S. 344: "Oberfläche selbst nicht oder kaum genarbt." Zu dieser Unterart rechne ich stark nodose Formen mit acht bis neun sehr betonten Warzen. Die hier abgebildete Form (Männchen und Weibchen) stammt aus Nordwestdeutschland.

Da vor allem die geflügelten Formen in Nordwestdeutschland in relativ großen Abständen erscheinen, und, wie ich schon weiter oben erwähnte, irgendwo anders sich in der Zwischenzeit weiter entwickelt haben, war ich natürlich neugierig, ob und wie eine irgendwo anders gefundene Form sich in die hier dargestellte Reihe einordnen läßt. Zu der Zeit, als ich mich mit der nordwestdeutschen Gattung *Gomphocythere* beschäftigte, erhielt ich zufällig einige brasilianische Proben. Eine davon enthielt Männchen und Weibchen einer *Gomphocythere*. Während das Weibchen aufgebläht und ohne Grobskulptur war, hatte das Männchen einen sehr betonten Flügel, gehörte also eindeutig zu *Gomphocythere*

forbesii. Hinter dem zweiten sulcus hatte das Männchen eine Warze. Seine stratigraphische Stellung war damit eindeutig geklärt. Diese Form gehörte als bisheriges Endglied der geflügelten Formen von *Gomphocythere* an den Anfang zu den nodosen Formen. Nach dieser Erfahrung glaube ich sagen zu können, daß man imstande sein wird, in Zukunft jede *Gomphocythere* irgendwie in die hier dargestellte Reihe der Gattung *Gomphocythere* einzuordnen.

DAS PROBLEM DER BRACKISCHEN OSTRACODEN

Seit 1938 habe ich mich viel mit brackischen Schichten beschäftigt, so auch unter anderem mit der Gattung *Cypridea*. Nie aber bin ich mit der bisherigen nomenklatorischen Behandlung einverstanden gewesen. Einerseits wußte ich, daß man sich die außerordentlichen stratigraphischen Vorteile, die sich aus den mannigfaltigen Skulpturen, zum Beispiel der Gattung *Cypridea*, ergeben, nicht entgehen lassen konnte. Schon 1940 habe ich versucht, auf die hier vorhandenen stratigraphischen Möglichkeiten hinzuweisen und, während ich in Jugoslawien war, hat Wolburg diese Arbeiten weiter fortgeführt und teilte allein den deutschen Wealden in sechs Zonen mit vielen Subzonen ein.

Andererseits war ich mir schon von Anfang an klar, daß die Vielfalt der Formen gerade im brackischen Milieu keineswegs bedeuten konnte, daß hier so viele Arten vorhanden waren. Gerade im brackischen Bereich sind Formenänderungen, zum Beispiel bei der Gattung *Cypridea*, aber auch bei anderen Gattungen weitgehend exogen bedingt. In ein und demselben Becken können sie nach unseren heutigen Erfahrungen in Nordwestdeutschland und England zweifellos außerordentlich zur stratigraphischen Klärung beitragen. Während des Krieges habe ich zum Beispiel Wealden in Ostdeutschland (Stettin) und Polen bearbeitet und habe keine Abweichungen von Nordwestdeutschland vorgefunden.

Das gleiche scheint von der Schweiz und von Spanien zu gelten. Man darf ja nie vergessen, wie resistent Ostracoden sind und daß sie weit vom Wind verschleppt werden können. In sonst trockenen Wagenspuren habe ich nach Regenfällen Ostracoden gefunden. Sogar mitten in Berlin fand ich sie in einer Gartentonne. Daher ist es keineswegs verwunderlich, wenn auch Grékoff (1953) glaubt, Beziehungen zwischen brackischen Schichten in Französisch-Nordkamerun, Gabon (Französisch Equatorial-Afrika), den Vereinigten Staaten von Nordamerika, Kanada und Brasilien aufstellen zu können. Solche Beziehungen bestehen, wie ich feststellen konnte, tatsächlich; wenn ich auch mit seinen stratigraphischen Einstufungen nicht ganz einverstanden bin, was ich demnächst an anderer Stelle beweisen werde.

Das Fazit meiner Untersuchungen, zumal in Nordwestdeutschland und England, möchte ich kurz so zusammenfassen: Jede skulptierte *Cypridea* (aber auch andere brackische Ostracoden) läßt sich mehr oder weniger einfach auf eine glatte (unskulptierte) *Cypridea* zurückführen. So sind zum Beispiel *Cypridea carinata* Martin, *Cypridea sowerbyi* Martin eindeutig Unterarten von *Cypridea inversa* (der Name ist unglücklich gewählt, denn es gibt noch andere inverse Cyprideen, aber der Name existiert nun einmal!). Diese Formengruppe müßte heißen: *Cypridea inversa inversa* Martin, *Cypridea inversa sowerbyi* Martin, und *Cypridea inversa carinata* Martin.

Cypridea fasciculata Forbes, *Cypridea dunkeri* Jones lassen sich wahrscheinlich auf *Cypridea altissima* Martin zurückführen. *Cypridea menevensis* Anderson ist die Stammform von *Cypridea spinigera* Sowerby, von der ich Formen kenne, die einen, zwei, drei oder vier Stacheln tragen. Es gibt eine *settina*-Gruppe, eine *angulata*-Gruppe, eine *parallela*-Gruppe und eine *inflata*-Gruppe, um nur einige zu nennen. Die Zahl der Arten läßt sich jedenfalls auf diese Weise auf mindestens ein Drittel (wahrscheinlich auf noch weniger) reduzieren.

Von der Gruppe der sogenannten Trapez-Ostracoden Wolburg's kenne ich bisher zwei glatte und sieben skulptierte Formen, davon bleibt eine Art mit acht Unterarten bestehen. Ich glaube, man wird auf diese Weise den genetischen Zusammenhängen auf alle Fälle besser gerecht.

LITERATURVERZEICHNIS

ANDERSON, F. W.

1938 – *Wealden and Purbeck Ostracoda*. Ann. Mag. Nat. Hist., ser. 11, vol. 3, pp. 291–310, pls. 12–13, 2 text-figs.

1940 – *Ostracoda from the Portland and Purbeck beds at Swindon*. Geol. Assoc., Proc., vol. 51, pt. 4, pp. 373–384, pls. 18–19.

1951 – *Note sur quelques ostracodes fossiles du Purbeckien de Suisse*. Arch. Sci., vol. 4, fasc. 3, pp. 209–212.

[MS.] *Purbeck and Wealden Ostracoda; I – The subfamily Cyprideinae Martin*. London: Palaeontographical Society (in press).

[MS.] *Ostracod faunas in the Purbeck beds of England*. London: Geological Society of London (in press).

ARKELL, W. J., AND SYLVESTER-BRADLEY, P. C.

1941 – *Notes on the age of the Swindon Purbeck beds*. Geol. Assoc., Proc., vol. 52, pt. 4, pp. 321–327.

ALEXANDER, C. I.

1929 – *Ostracoda of the Cretaceous of north Texas*. Texas, Univ., Bull., no. 2907, pp. 7–137, 10 pls., 2 maps.

BRANSON, C. C.
1935 – *Freshwater invertebrates from the Morrison (Jurassic?) of Wyoming*. Jour. Pal., vol. 9, no. 6, pp. 514–522, pl. 57.
1936 – *New name for a Morrison ostracode genus*. Jour. Pal., vol. 10, no. 4, p. 323.

DEFRETIN, S., AND BOUREAU, E.
1952 – *Le Wealdien du Nord-Cameroun*. Acad. Sci., C. R., vol. 234, no. 14, pp. 1459–1460.

FORBES, E.
1851 – *On the succession of strata and distribution of organic remains in the Dorsetshire Purbecks*. British Assoc. Adv. Sci., Rept. (1850), pt. 2, pp. 79–81.

GRÉKOFF, N.
1953 – *Sur l'utilisation des microfaunes d'ostracodes dans la stratigraphie précise du passage Jurassique-Crétacé (faciès continentaux)*. Inst. Franç. Pétrole, Rev., vol. 8, no. 7, pp. 362–379, text-figs. 1–11.

HARPER, F., AND SUTTON, A. H.
1935 – *Ostracodes of the Morrison formation from the Black Hills, South Dakota*. Jour. Pal., vol. 9, no. 8, p. 623–628, pl. 76.

JONES, T. R.
1849 – *A monograph of the Entomostraca of the Cretaceous formation of England*. Palaeontogr. Soc. London, Monogr., pp. 1–40, pls. 1–7.
1860 – *Fossil Entomostraca from Montserrate (Brazil)*. Geol. Soc. London, Quart. Jour., vol. 16, pp. 266–268, pl. 16.
1878*a* *Notes on some fossil bivalved Entomostraca*. Geol. Mag., dec. 2, vol. 5, pp. 100–110, pl. 3.
1878*b* *On the Wealden Entomostraca*. Ibid., dec. 2, vol. 5, pp. 277–278.
1880 – *Lettre sur le "Calcaire à Cypris" du Boulonnais*. Soc. Géol. France, Bull., ser. 3, vol. 8, pp. 615–616.
1885*a* *On the Ostracoda of the Purbeck formation, with notes on the Wealden species*. Geol. Soc. London, Quart. Jour., vol. 41, pp. 311–353, pls. 8–9.
1885*b* *On the Ostracoda of the Purbeck formation*. Ann. Mag. Nat. Hist., ser. 5, vol. 16, pp. 231–232.
1886 – *On some fossil Ostracoda from Colorado*. Geol. Mag., new ser., dec. 3, vol. 3, no. 4, pp. 145–148, pl. 4.
1888 – *Ostracoda from the Weald clay of the Isle of Wight*. Geol. Mag., new ser., dec. 3, vol. 5, pp. 534–539.
1893 – *On some fossil Ostracoda from south-western Wyoming and from Utah, U.S.A.* Geol. Mag., new ser., dec. 3, vol. 10, pp. 385–391, pl. 15.

LORANGER, D. M.
1951 – *Useful Blairmore microfossil zone in central and southern Alberta, Canada*. Amer. Assoc. Petr. Geol., Bull., vol. 35, no. 11, pp. 2348–2367, pls. 1–3, text-figs. 1–3.

LORIOL, P. DE, AND JACCARD, A.
1865 – *Étude géologique et paléontologique de la formation d'eau douce infracrétacé du Jura*. Soc. Phys. Hist. Nat. Genève, Mém., vol. 18, pt. 1, pp. 64–128.

MARTIN, G. P. R.
1940 – *Ostracoden des norddeutschen Purbeck und Wealden*. Senckenbergiana, vol. 22, no. 5/6, pp. 275–361, pls. 1–13.

TAFEL 1

1 *Gomphocythere forbesii* (Jones) subsp. *planiverrucosa* (Klingler)
Männlich; größte Länge 1,02 mm.; größte Breite 0,49 mm.; größte Höhe 0,58 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Westerbeck 6; 825,1 meter; Unter-Kimmeridge.

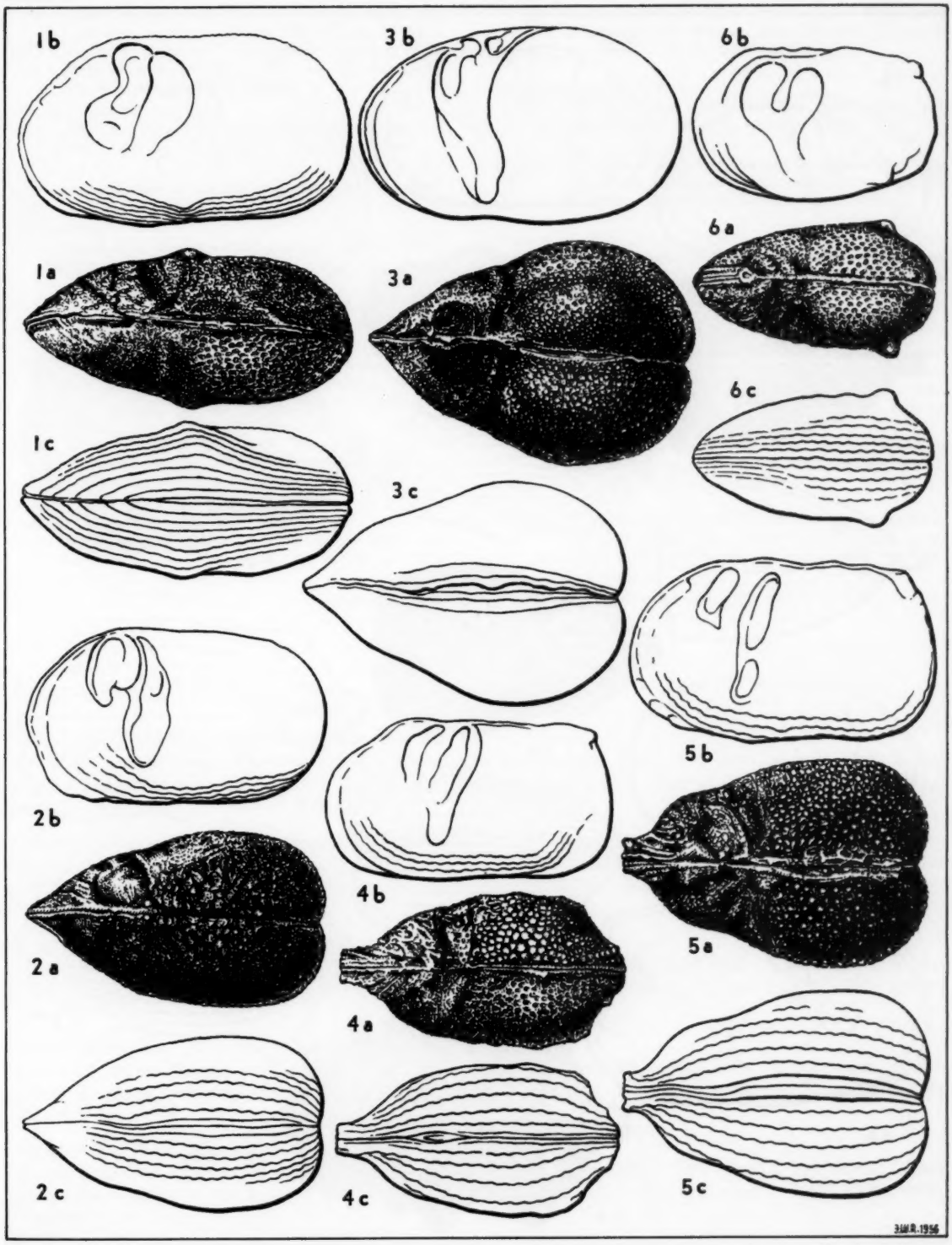
2 *Gomphocythere forbesii* (Jones) subsp. *planiverrucosa* (Klingler)
Weiblich; größte Länge 0,90 mm.; größte Breite 0,54 mm.; größte Höhe 0,54 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Westerbeck 6; 825,1 meter; Unter-Kimmeridge.

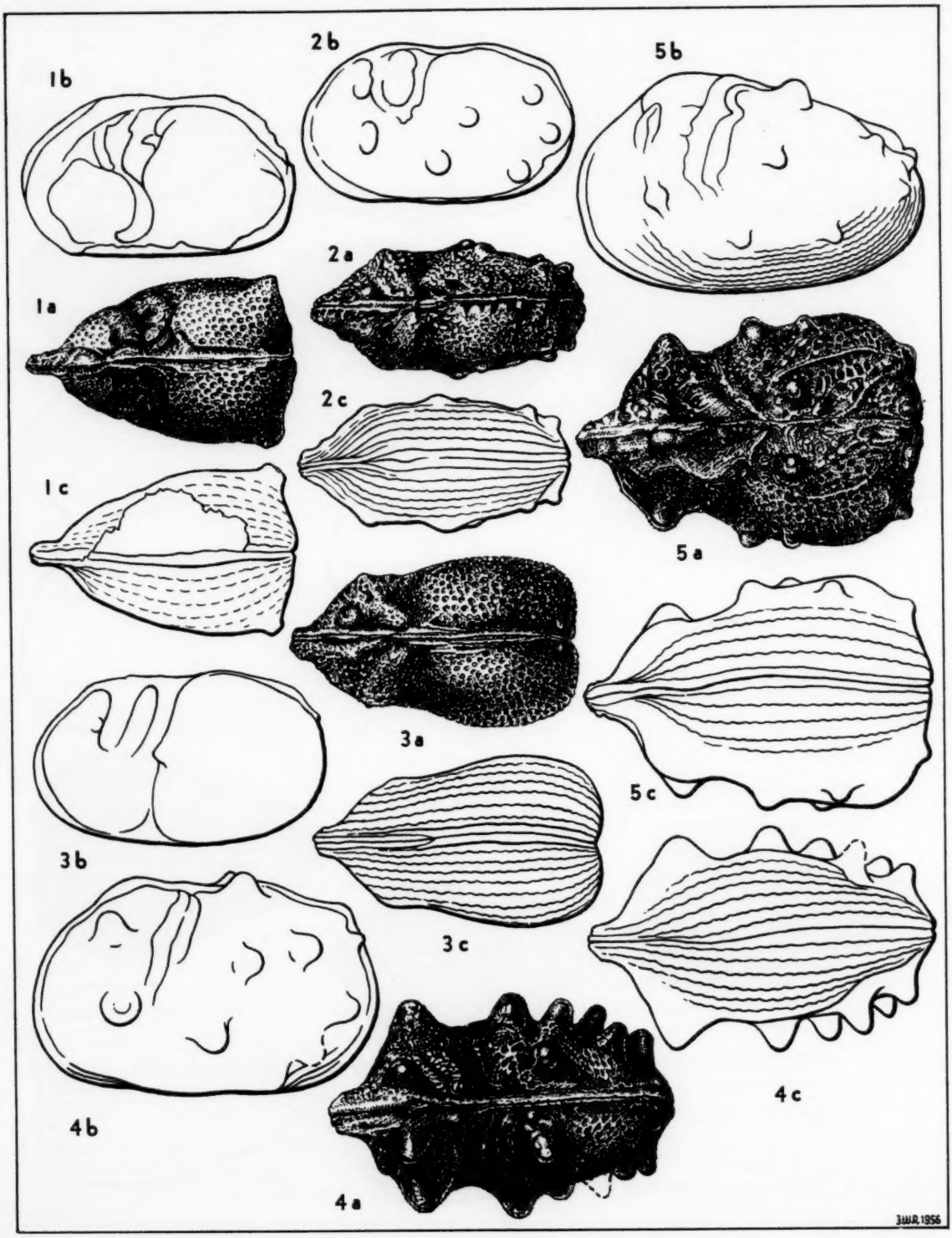
3 *Gomphocythere forbesii* (Jones) subsp. *forbesii* (Jones)
Weiblich; größte Länge 1 mm.; größte Breite 0,69 mm.; größte Höhe 0,61 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Ehra 42; 211–213 meter; Serpulit.

4 *Gomphocythere forbesii* (Jones) subsp. *striata* Martin
Männlich; größte Länge 0,89 mm.; größte Breite 0,47 mm.; größte Höhe 0,49 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Wahn 4; 297 meter; Wealden 1.

5 *Gomphocythere forbesii* (Jones) subsp. *striata* Martin
Weiblich; größte Länge 0,95 mm.; größte Breite 0,63 mm.; größte Höhe 0,57 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Wahn 4; 299,3 meter; Wealden 1.

6 *Gomphocythere forbesii* (Jones) subsp. *silvana* Martin
Männlich; größte Länge 0,71 mm.; größte Breite 0,42 mm.; größte Höhe 0,48 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Georgsdorf 105; 1241,5 meter; Wealden 3a.


1b
3b
6b
6a
1a
3a
6c
1c
3c
5b
2b
4b
5a
2a
4a
2c
4c
5c
3.M.R.1956


1b
2b
5b
2a
1a
2c
1c
5a
3a
5c
3b
3c
4b
4c
4a
JWR 1956

PECK, R. E.
1941 – *Lower Cretaceous Rocky Mountain nonmarine microfossils.* Jour. Pal., vol. 15, no. 3, pp. 285–304, pls. 42–44.
1951 – *Nonmarine ostracodes; The subfamily Cyprideinae in the Rocky Mountain area.* Jour. Pal., vol. 25, no. 3, pp. 307–320, pls. 48–50, 1 text-fig.

RIEDEL, L., AND WICHER, C. A.
1942 – *Zur Grenze Jura-Kreide in Nordwestdeutschland.* Oel und Kohle, vol. 38, no. 34, pp. 1019–1021.

ROTH, R.
1933 – *Some Morrison Ostracoda.* Jour. Pal., vol. 7, no. 4, pp. 398–405, pl. 48.

ROYOY GOMEZ, J.
1927 – *Sur le faciès Wealdien d'Espagne.* Soc. Géol. France, C. R. Somm., no. 11, pp. 125–128.

SARS, G. O.
1924 – *The fresh-water Entomostraca of the Cape Province (Union of South Africa); Part 2 – Ostracoda.* South African Mus., Ann., vol. 20, pp. 105–193, pls. 2–20.
1928 – *An account of the Crustacea of Norway with short descriptions and figures of all the species.* Bergen: Bergen Museum, vol. 9 (Ostracoda), pp. i–xii, 1–265, pls. 1–119.

SCHMIDT, H., AND WOLBURG, J.
1949 – *Die stratigraphische Stellung des Purbeck in der südlichen Hilsmulde.* Akad. Wiss. Göttingen, Math.-Phys. Kl., Nachrichten, pp. 19–25, text-fig. 1.

SWAIN, F. M.
1946 – *Middle Mesozoic nonmarine Ostracoda from Brazil and New Mexico.* Jour. Pal., vol. 20, no. 6, pp. 543–555, pls. 83–84, 1 text-fig.

SWARTZ, F. M., AND SWAIN, F. M.
1946 – *Ostracoda from the Upper Jurassic Cotton Valley group of Louisiana and Arkansas.* Jour. Pal., vol. 20, no. 4, pp. 326–373, pls. 52–53, 1 text-fig.

SYLVESTER-BRADLEY, P. C.
1940 – *The Purbeck beds of Swindon.* Geol. Assoc., Proc., vol. 51, pt. 4, pp. 349–372, text-figs. 49–51.
1949 – *The ostracod genus Cypridea and the zones of the Upper and Middle Purbeckian.* Geol. Assoc., Proc., vol. 60, pt. 2, pp. 125–153, pls. 3–4, text-figs. 17–25.

WICHER, C. A.
1940 – *Zur Stratigraphie der Grenzschichten Jura-Kreide Nordwestdeutschlands.* Oel und Kohle, vol. 36, no. 29, pp. 263–269, pls. 1–3, text-figs. 1–3.

WOLBURG, J.
1949*a* *Ergebnisse der Biostratigraphie nach Ostracoden im nordwestdeutschen Wealden.* In: BENTZ, A. (ed.), *Erdöl und Tektonik in Nordwestdeutschland.* Hannover-Celle: Amt für Bodenforschung, pp. 349–360, text-figs. 1–7.
1949*b* *Zur Frage des Alters der obersten Wealdenschichten in England.* Neues Jahrb. Min., Monatshefte, pt. B, no. 7, pp. 193–197, text-fig. 1.
1950 – *Vergleichende stratigraphische Untersuchungen der brackisch-limnischen Ablagerungen Europas an der Wende Jura-Kreide.* Geol. Jahrb., vol. 64 (1943–1948), pp. 159–171, pls. 1–2.

TAFEL 2

1 *Gomphocythere forbesii* (Jones) subsp. *silvana* Martin
Weiblich; größte Länge 0,81 mm.; größte Breite 0,54 mm.; größte Höhe 0,49 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Georgsdorf 105; 1241,5 meter; Wealden 3a.

2 *Gomphocythere fittoni* (Mantell) subsp. *fittoni* (Mantell)
Männlich; größte Länge 0,81 mm.; größte Breite 0,4 mm.; größte Höhe 0,48 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Lingen 1; 1321–1324 meter; Wealden 4.

3 *Gomphocythere fittoni* (Mantell) subsp. *fittoni* (Mantell)
Weiblich; größte Länge 0,9 mm.; größte Breite 0,5 mm.; größte Höhe 0,54 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Lingen 1; 1321–1324 meter; Wealden 4.

4 *Gomphocythere fittoni* (Mantell) subsp. *berwickensis* Martin
Männlich; größte Länge 1,08 mm.; größte Breite 0,7 mm.; größte Höhe 0,69 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Lingen 1; 1307–1309 meter; Wealden 4.

5 *Gomphocythere fittoni* (Mantell) subsp. *berwickensis* Martin
Weiblich; größte Länge 1,08 mm.; größte Breite 0,71 mm.; größte Höhe 0,61 mm.: a, von oben; b, das gleiche Exemplar von der Seite; c, das gleiche Exemplar von unten. Bohrung Lingen 1; 1307–1309 meter; Wealden 4.

ABSTRACT: *A formula system for the temporary classification of fossil pollen and spore types is suggested. The system is a shorthand method which first classifies pollen and spores on the basis of morphology and then further subdivides the morphological classification on the basis of sculpturing. The system is rapid, comprehensive, versatile, expansible, and simple enough to permit its use by new workers in the field with a minimum of training.*

Pollen and spore formulae — A suggestion

ROBERT H. TSCHUDY
Palynological Research Laboratory
Boulder, Colorado

INTRODUCTION

The recent rapid growth of palynology and the ingress into its ranks of many persons with no formal background in botanical nomenclature have demonstrated the need for an easy and rapid method of categorizing the numerous plant microfossils encountered in ancient sediments. The problem is complicated by the multitude of unnamed and undescribed species encountered. The nomenclatural difficulties are so great as to restrain publication of stratigraphic results of palynological work, particularly from Tertiary and older sediments. Problems of classification should, of course, be handled within the framework of the International Rules of Botanical Nomenclature. However, stratigraphic problems and results can be presented quite adequately before formal classification of all the species encountered. It is with this objective in mind that this suggestion for a practical pollen and spore coding system is presented.

The need for an easy, rapid method for the temporary classification of fossil pollen and spore types has long been recognized. For various reasons, the pollen and spore "formulae" suggested in the past have failed to meet the requirements of new workers in the field and, consequently, have not been adopted. Characteristics of a workable formula or coding system are (1) versatility—adaptability to any new exotic forms encountered; (2) comprehensiveness—as nearly all-inclusive as possible; (3) expansibility—the formula should describe the grain or spore so that other workers would be able to place it in any similar coding system they may be using; and (4) simplicity of application. Each new specimen must be placeable accurately into its appropriate niche. The spore and pollen formula system used in our laboratory has worked admirably for years. We are publishing this account in the hope that it will be an aid to those beginning the study of the myriad of new Tertiary and Paleozoic pollen and spores. Our system was originally designed to encompass the Tertiary microfossils encountered in South American sediments. We have recently expanded our system to include spores, pollen, and prepollen from pre-Tertiary sediments.

POLLEN TYPES

Several workers have classified modern pollen types and provided a catalog in which they may be placed. Selling (1947) has presented the "Pollen types of pre-European Hawaiian phanerogams." More recently, Faegri and Iversen (1950) have presented a list of pollen classes, modified from the suggestions of Iversen and Troels-Smith (1950). Faegri and Iversen have also suggested a pollen formula system in their recent handbook of pollen analysis. Kuyl, Muller, and Waterbolk (1955) have slightly modified the Faegri and Iversen system and added a group of genera of Paleozoic spore types. With these three systems of classification of pollen and spore types, it is possible to place most new pollen grains or spores in an appropriate niche. Table 1 lists the spore and pollen classes published by Selling, Faegri and Iversen, and Kuyl, Muller, and Waterbolk, together with our "shorthand" method of designating these classes. We have appended to the table our "shorthand" designations of the genera of fossil spores included in "An anno-

TABLE 1

SELLING	FAEGRI AND IVERSEN	KUYL, MULLER AND WATERBOLK	"SHORTHAND CODE"	SCHOPF, WILSON, AND BENTALL DESIGNATIONS NOT LISTED PREVIOUSLY	"CODE"
Non Aperturate	Inaperturatae		Inaperturate O	Tasmanites	Tas
Mono-Sulcate	(Aberrent grains)	Syncolpatae		Cystosporites	Cy
Di-	Syncolpatae	Operculatae	Sulcate S_1	Triletes	Tl
Trichotomo-		Trichotomocolpatae	S_2	Zonalo-sporites	Z
Mono-colpate	Monocolpatae	Monocolpatae	Colpate C_1	Monoletes	M
Di-	Dicolpatae	Dicolpatae	C_2	Parasporites	Par
Tri-	Tricolpatae	Tricolpatae	C_3	Equisetosporites	Eq
Tetra-	Stephanocolpatae	Stephanocolpatae	$C\infty$	Pityosporites	Pit
Penta-				Alisporites	Ali
Octa-					
Hexa- (Demi-colporatae)	Heterocolpatae	Heterocolpatae	h		
Di-colporate	Dicolporatae	Dicolporatae	Colporate CP_2		
Tri-	Tricolporatae	Tricolporatae	CP_3	GENERALIZED TEMPORARY CODE DESIGNATIONS	
Tricolpodiporate	Stephanocolporatae	Stephanocolporatae	$CP\infty$		
Tetra-				Monolaesurate	ml
Penta-				Trilaesurate	tl
Hexa-Rugate	Pericolpatae	Pericolpatae	Rugate R	Vesiculate (includes all vesiculate forms; can be divided later into: V (Di)—Disaccate forms; V (Fl)—Florinites; V (Pit)—Pityosporites, etc.	V
Poly-					
Septa-Rugoporate	Pericolporatae	Pericolporatae	$CP\infty$		
Poly-					
Mono-porate	Monoporatae	Monoporatae	Porate P_1		
Di-	Diporatae	Diporatae	P_2		
Tri-	Triporatae	Triporatae	P_3		
Tetra-	Stephanoporatae	Stephanoporatae	$P\infty$	Flanged (Cincturate) (includes all cincturate forms; can be divided later into: F(Lyc)—Lycospora; F(D)—Densosporites; F(Cir)—Cirratriradites, etc.	F
Penta-	Periporatae	Periporatae			
Poly-					
Pseudomonads	Dyadae	Dyadae	Dyads Dy		
Tetrads	Tetradae	Tetradae	Tetrads } T		
Massulae	Polyadae	Polyadae	Polyads }		
Pollinia					
		Zonoratae			
	Fenestratae				
	Extraporatae				
	Vesiculatae			OTHER CODE DESIGNATIONS IN USE IN OUR LABORATORY	
		Aletes	O		
		Laevigatosporites	L	Fungus	U
		Granulatisporites	G	Indeterminate or probably animal	I
		Punctatisporites	Pu	Microforaminifera	For
		Triquitrites	Tri	Hystrichosphaeridae	Hyst
		Densosporites	D	Dinoflagellates	Din
		Raistrickia	Rs		
		Reinschospora	Rein	New genera when established, e. g., *Trilobates* (Somers, 1952), could be given a distinctive code designation such as Tb.	
		Reticulatisporites	Ret		
		Cirratriradites	Cir		
		Lycospora	Lyc		
		Calamospora	Cal		
		Florinites	Fl		
		Endosporites	End		
		Alatisporites	Alat		
		Illinites	Il		
		Inaperturatae	O		
		Monocolpatae	C_1		
		Polyplicatae	C_1 (∞) or possibly Gn – Gnetales		
		Vesiculatae	V		

tated synopsis of Paleozoic fossil spores and the definition of generic groups" by Schopf, Wilson, and Bentall (1944). As new genera of fossil spores are discovered and published, the shorthand designations for these new genera can be constructed readily. In addition, as new "species" are encountered, if no category exists, an appropriate category may be created to fit the characteristics of the fossil type. Examples are listed at the end of the table under the heading "Other code designations in use in our laboratory."

Further subdivision of such a coding classification system is desirable and often necessary. This may be effected by a consideration of the sculpturing of the pollen or spore under inspection. The ability to subdivide becomes important when placing tentative "species" belonging to such a large class as, for instance, tricolpate pollen, which encompasses literally hundreds of undescribed new species. Originally we subdivided our classes into subclasses, viz., smooth (Sm), rough (R), and spiny (Sp). Thus, our code designation for a smooth tricolpate pollen was C_3Sm followed by a numeral indicating the species considered, i.e., C_3Sm–27. We have found that this subdivision might well be expanded and are suggesting that instead of three sculpturing categories, six sculpturing categories would be more useful (see Table 3). Faegri and Iversen (1950, p. 27) have presented the logical, well defined descriptions of sculpturing elements encountered on pollen and spore coats shown in Table 2.

TABLE 2

Foveolate	pitted
Psilate	smooth
Verrucate	warty
Fossulate	grooved
Scabrate	scaly
Gemmate	bud-like
Baculate	rod-shaped
Clavate	club-shaped
Echinate	spiny
Rugulate	ridged
Striate	parallel ridges
Reticulate	network

A. Sculpturing elements s.s. absent
  B. Surface even or diameter of pits $< 1\mu$ . . . psilate *(Betula)*
  BB. Surface pitted, diameter of pits $\leq 1\mu$ . . . foveolate *(Lycopodium selago)*
  BBB. Surface with grooves . . . fossulate *(Ledum palustre)*

AA. Radial projection of sculpturing elements $\pm$ isodiametric
  B. No dimension $\leq 1\mu$ . . . scabrate *(Artemisia campestris)*
  BB. At least one dimension $\leq 1\mu$
    C. Sculpturing elements not pointed
      D. Greatest diameter of radial projection greater than height of element
        E. Lower part of element not constricted . . . verrucate *(Plantago major)*
        EE. Lower part of element constricted . . . gemmate *(Juniperus)*
      DD. Height of element greater than greatest diameter of projection
        E. Upper end of element not thicker than base . . . baculate *(Nymphaea)*
        EE. Upper end of element thicker than base . . . clavate *(Ilex)*
    CC. Sculpturing elements pointed . . . echinate *(Malva)*

AAA. Radial projections elongated (length at least twice the breadth)
  B. Elements irregularly distributed . . . rugulate *(Nymphoides peltatum)*
  BB. Elements parallel . . . striate *(Menyanthes)*
  BBB. Elements forming a reticulum . . . reticulate *(Fritillaria)*

With this system as a basis, we have designed a method of telescoping the twelve sculpturing descriptions into six shorthand designations, as shown in Table 3.

TABLE 3

Psilate (smooth)		sm
Foveolate		f
Scabrate, Verrucate, Gemmate, Baculate, Clavate	(projections)	p
Echinate (spiny)		sp
Fossulate, Rugulate, Striate	(striate)	st
Reticulate		r

Thus, a triporate pollen grain with reticulate sculpturing would be designated P_3r, plus a number indicating a tentative species designation, as P_3r–7. A more elaborate system employing the twelve sculpturing descriptions can, of course, be designed should one wish.

The application of such a formula or coding system as used in our laboratory is simple. A suspected new species is first compared with all camera lucida drawings of specimens that are somewhat similar in structure and sculpturing. After elimination of those whose characteristics obviously do not coincide with those of the specimen involved, a final comparison is made with similar, permanent type-slide material on file for each code species. If the new specimen possesses characteristics at variance with those on file, it is considered a new species. If the latest-coded species in our files, for instance, is P_3r–7, the next new species becomes P_3r–8. A camera lucida drawing is made of the new "species," and the slide number and mechanical stage coordinates are listed with the drawing. The slide then becomes a type slide and is so indicated in our card catalog. By this method, new species can usually be established in less than five minutes' time, even though we are now carrying in our files about 2000 code species of fossil pollen and spores.

ADVANTAGES

1) The method is rapid and simple.

2) A temporary or permanent niche is available for each specimen, thus providing a code name or category for all specimens until such time as species variability is well established. A botanical species might thus encompass three or more code or formula species.

3) Such a system will tend to reduce the publication of species names of questionable validity, particularly in instances in which affinities with modern plants have not yet been established.

4) The system can easily be expanded and modified to include any new microfossil that may be encountered, whether of animal, plant, or unknown affinity.

BIBLIOGRAPHY

FAEGRI, K., AND IVERSEN, J.
1950 – *Text-book of modern pollen analysis*. Copenhagen: Ejnur Munksgaard, 168 pp.

IVERSEN, J., AND TROELS-SMITH, J.
1950 – *Pollenmorphologiske definitioner og typer*. Danmarks Geol. Unders., ser. 4, vol. 3, no. 8, pp. 1–54.

KUYL, O. S., MULLER, J., AND WATERBOLK, H. T.
1955 – *The application of palynology to oil geology with reference to western Venezuela*. Geologie en Mijnbouw, new ser., vol. 17, no. 3, pp. 49–76.

SCHOPF, J. M., WILSON, L. R., AND BENTALL, R.
1944 – *An annotated synopsis of Paleozoic fossil spores and the definition of generic groups*. Illinois, State Geol. Survey, Rept. Invest., no. 91, pp. 1–73.

SELLING, O. H.
1947 – *Studies in Hawaiian pollen statistics; Part II – The pollens of the Hawaiian phanerogams*. Bernice P. Bishop Mus., Spec. Publ., no. 38, 430 pp.

SOMERS, G.
1952 – *A preliminary study of the fossil spore content of the lower Jubilee seam of the Sydney coalfield, Nova Scotia*. Halifax: Nova Scotia Research Foundation, 30 pp.

ABSTRACT: *The algal genus* Clypeina *has been recognized in the upper Middle Eocene Avon Park limestone of the Florida subsurface.* Clypeina infundibuliformis, Clypeina pezanti, *and* Clypeina digitata *have been previously described from the Middle Eocene of the Paris Basin.* Clypeina johnsoni *is described here for the first time. The ambiguity of the descriptions of the previously named species has made it necessary to redefine them here.*

Occurrence of Clypeina in the Eocene of Florida

RICHARD REZAK
U. S. Geological Survey
Denver, Colorado

INTRODUCTION

The presence of fossil algae in the Avon Park limestone (late Middle Eocene) of Florida has been known for several years (Applin and Applin, 1944, p. 1687). However, they have not been previously described nor identified in the published record. Recently, Mrs. Applin sent cuts of two well samples from the Avon Park containing specimens of these algae to me for examination. The samples contained up to 75 per cent of algal debris consisting of numerous individuals of *Clypeina* species. Three of these species have been previously described from the Eocene of the Paris Basin (Morellet and Morellet, 1913 and 1922); a fourth species has not been previously described.

The extinct genus *Clypeina* Michelin is a member of the family Dasycladaceae, one of the groups of siphonous green algae. Modern representatives of the family include the genus *Acetabularia* Lamouroux (popularly known as the mermaid's wineglass), a close relative of *Clypeina*. Living Dasycladaceae are restricted to tropical and subtropical shallow marine waters. It is believed that the Avon Park limestone was deposited in a similar environment.

The samples had been washed before they were sent to me. However, the fossils were partly covered by films of silt-size particles which could not be removed by washing. These films were easily removed with no damage to the fossils by treating the sample for five minutes in an ultrasonic transducer.

The localities from which the present specimens were obtained are:

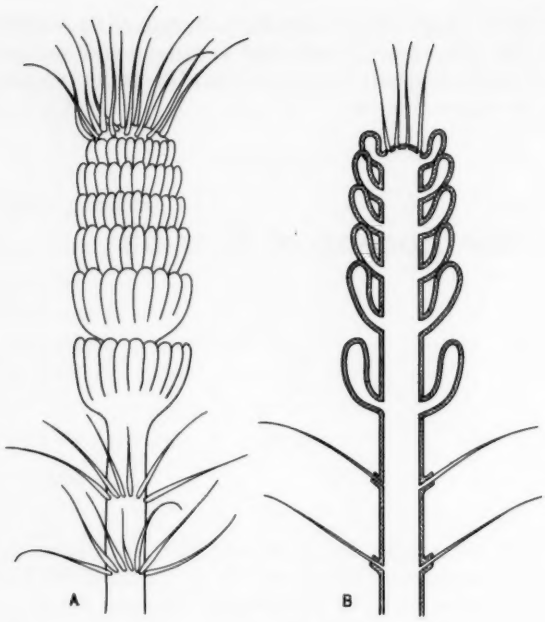
Paleobotany locality no. D612: Water well, depth 140 feet, U. S. Army, Kissimmee Airfield, cantonment area, located 400 feet north and 1800 feet west from the southeast corner of sec. 19, T. 25 S., R. 29 E., two miles west of Kissimmee, Osceola County, Florida. Elevation 78 feet. This sample is listed in the Florida Geological Survey files as W–697.

Paleobotany locality no. D613: Florida Public Service Company well at Lake Wales. Depth 560 feet. New water-tank site in the center of Lake Wales, about in the center of the east half of sec. 2, T. 30 S., R. 27 E., Polk County, Florida. Elevation about 205 feet. This sample is listed in the Florida Geological Survey files as W–500.

I should like to express my appreciation to Mrs. Esther R. Applin for sending me the materials on which this paper is based. Wendell Walker of the U. S. Geological Survey was extremely helpful in working out the technique of photographing these fossils in stereoscopic pairs. The photographs on plate 1 are all stereoscopic pairs, and can be viewed with an ordinary pocket stereoscope. Publication of this paper has been authorized by the Director of the U. S. Geological Survey. The types and figured specimens are deposited in the U. S. Geological Survey Algae Collection, Denver Federal Center, Denver, Colorado.

CLASSIFICATION AND RELATIONSHIPS

The genus *Clypeina* has been classified among the corals (Michelin, 1845, p. 177), the bryozoans (d'Orbigny, 1850, p. 397), and the foraminifera (Parker and Jones, 1860, p. 474; Carpenter, Parker and Jones, 1862, p. 130; Gümbel, 1872, p. 262). In 1877, Munier-Chalmas demonstrated (1877, p. 814) that *Clypeina* belongs to the plant kingdom and is in



TEXT-FIGURE 1

Reconstruction of *Clypeina* sp., × 15 (after Morellet and Morellet, 1918). A, upper extremity of a thallus showing sterile discs at base; above these are six fertile discs nested one above the other, and at the apex a cluster of sterile branches. B, longitudinal section of A; shaded areas indicate calcareous parts.

reality one of the dasyclads. He placed the genus (1877, p. 817) near *Halicoryne* Harvey in the family Cymopolidae (no longer a valid taxon). The general practice in recent years has been to maintain the dasyclads in a single family, the Dasycladaceae, which is subdivided into several tribes. *Halicoryne*, according to Solms-Laubach (1895, p. 19), stands near the ancestral form of the family Acetabularieae (now regarded as a tribe), and was placed by him in that taxon. It was pointed out by the Morellets (1913, p. 31, and 1918, p. 103) that the genus *Clypeina* should be included, along with *Halicoryne*, in this family because of its general aspect and the clearly distinct arrangement of the sporangial and sterile discs. (See text-figure 1.) Pia (1927, p. 71) placed the genus in the tribe Diploporeae, believing that *Clypeina* was descended from either *Physoporella* Steinmann (Middle Triassic) or *Actinoporella* Alth (Upper Jurassic). Emberger (1944, p. 75) accepted this assignment without question. Pia's statement (Pia, 1927, p. 693) that the occurrence of the genus in the Upper Jurassic favors his interpretation of its systematic position hardly seems justified when comparisons are made between *Clypeina*, *Halicoryne*, and the Diploporeae. The results of my present work and a review of publications concerned with the genus *Clypeina* substantiate its assignment to the tribe Acetabularieae.

SYSTEMATIC DESCRIPTIONS

Division CHLOROPHYCOPHYTA

Class CHLOROPHYCEAE

Order DASYCLADALES

Family DASYCLADACEAE

Tribe ACETABULARIEAE

Genus **Clypeina** Michelin, 1845, **emend.** Rezak

Emended diagnosis: Thallus calcified, composed of a siphonous stipe bearing at its apex one or more whorls of sporangial rays or discs; the apex of the stipe bears a variable number of vertically disposed sterile branches or hairs.

Type species: Clypeina marginoporella Michelin (Stampian).

Remarks: Species are distinguished on the basis of the diameter of the disc; the number, shape, and diameter of the rays of the disc; and the diameter of the stipe. In many cases it is difficult to determine the diameter of the disc because the distal extremities of the rays have been destroyed. The measurements in the following descriptions of species are, to the best of my knowledge, taken from complete discs.

Because of the ambiguity of the Morellets' descriptions of species, it was necessary to make measurements on their published figures. These are given in Table 1, and include the diameter of the rays, which they did not recognize as a specific characteristic.

Clypeina digitata (Parker and Jones) Morellet and Morellet, **emend.** Rezak
Plate 1, figure 13

Dactylopora digitata PARKER AND JONES, 1860, Ann. Mag. Nat. Hist., ser. 3, vol. 5, p. 474. – CARPENTER, PARKER AND JONES, 1862, Introd. Study Foram., p. 130, text-fig. 27, pl. 10, fig. 16.

Haploporella digitata (Parker and Jones). – GÜMBEL, 1872, K. Bayer. Akad. Wiss. München, Math.-Physik. Cl., Abh., vol. 11, pt. 1, p. 262, pl. 1, fig. 15; pl. 4, fig. 7.

Clypeina digitata (Parker and Jones). – MORELLET AND MORELLET, 1913, Soc. Géol. France, Mém., vol. 21, fasc. 1, no. 47, p. 35, pl. 3, figs. 26–31.

Clypeina stelliformis MORELLET AND MORELLET, 1939, *Tertiary siphoneous Algae*, p. 28.

Clypeina pezanti MORELLET AND MORELLET, 1939 (part), ibid., p. 48, pl. 6, figs. 26–27 (not fig. 25).

TABLE 1

MEASUREMENTS (IN MM.) OF THE MORELLETS' FIGURES (1913 AND 1922)

Species	Diameter of disc	Diameter of stipe	Number of rays	Diameter of rays	Specimens measured
Clypeina infundibuliformis	0.90–1.05	0.25–0.49	12–26	0.10–0.17	1913, pl. 3, figs. 20–25
Clypeina pezanti	1.40–1.72	0.42–0.59	10–20	0.16–0.31	1922, pl. 2, figs. 37–44
Clypeina digitata	1.0 –1.4	0.2 –0.5	7–16	0.11–0.18	1913, pl. 3, figs. 26–31
MEASUREMENTS OF THE AVON PARK SPECIMENS					
Clypeina infundibuliformis	0.92–1.18	0.24–0.486	12–22	0.064–0.12	20 specimens
Clypeina pezanti	1.728	?(large)	10	0.162	1 specimen
Clypeina johnsoni, n. sp.	1.18–1.56	0.38–0.64	16–30	0.108	6 specimens
Clypeina digitata	0.97	0.27–0.29	5–9	0.05 –0.27	3 specimens

Emended description: Disc flat or nearly flat, 0.97 to 1.4 mm. in diameter, consisting of seven to sixteen elongate, conical rays, 0.108 to 0.18 mm. in diameter at base, tapering to about 0.05 mm. at extremities; stipe cylindrical, 0.2 to 0.5 mm. in diameter. Rays of disc not in contact with each other for most of their length.

Comparisons: The flattened open nature of its disc easily distinguishes *Clypeina digitata* from all other species except *Clypeina helvetica* Morellet and Morellet (1918), which has a similar type of disc but is much larger in all dimensions.

Remarks: Parker and Jones (1860) gave a brief description of the species without an illustration. Carpenter, Parker and Jones (1862) illustrated an incomplete specimen which shows most of the characters of the species. It was not until 1872 that a complete disc was illustrated by Gümbel (1872, pl. 1, fig. 15) under the name *Haploporella digitata*. Unfortunately, Gümbel did not refer to the illustration in his plate explanation, but the figure is clearly identified in the text (Gümbel, 1872, p. 262). In 1913 the Morellets described and illustrated specimens of this species from the Paris Basin. In 1939 (pp. 27–28), after some involved reshuffling of species, they decided that they had misidentified the specimens which they had assigned in 1913 to *Clypeina digitata*. The misidentified specimens were given the name *Clypeina stelliformis*. At the same time they concluded that the types of *Clypeina digitata* were in reality the same as their *Clypeina pezanti* (1922). Because Parker and Jones had not illustrated their species, and because Carpenter illustrated the species with an incomplete specimen, the Morellets decided that the name *Clypeina digitata* was invalid, and placed it in synonymy with their *Clypeina pezanti*. No mention was made of Gümbel's *Haploporella digitata*. I believe that the name *Clypeina digitata* was validly published and should be retained, whereas the name *Clypeina stelliformis* should be rejected.

The three specimens on Parker and Jones' slide V.24920 were illustrated by the Morellets (1939, pl. 6, figs. 25–27) under the name *Clypeina pezanti*. Actually, specimens no. 1 and no. 3 on this slide are *Clypeina digitata*, no. 3 being the type of this species. Specimen no. 3 was illustrated as such by Carpenter, Parker and Jones (1862, pl. 10, fig. 16). Specimen no. 2 was illustrated by Carpenter, Parker and Jones under the name *Dactylopora clypeina* (1862, pl. 10, fig. 15). *Dactylopora clypeina* is a senior synonym of *Clypeina pezanti* (see the remarks under that species).

Clypeina pezanti Morellet and Morellet, **emend.** Rezak

Plate 1, figure 14

Dactylopora clypeina CARPENTER, PARKER AND JONES, 1862, Introd. Study Foram., p. 131, pl. 10, fig. 15.

Haploporella marginoporella GÜMBEL, 1872, K. Bayer. Akad. Wiss. München, Math.-Physik. Cl., Abh., vol. 11, pt. 1, p. 262, pl. 4, fig. 6a–b.

Clypeina pezanti MORELLET AND MORELLET, 1922, Soc. Géol. France, Mém., vol. 25, fasc. 2, no. 58, p. 27, pl. 2, figs. 37–44; 1939 (part), *Tertiary siphoneous Algae*, pp. 27–28, pl. 6, fig. 25 (not figs. 26–27).

Not *Clypeina marginoporella* MICHELIN, 1845, Iconogr. zooph., livr. 16–20, p. 177, pl. 46, fig. 27.

Emended description: Disc bowl-shaped, 1.40 to 1.728 mm. in diameter, consisting of ten to twenty cylindrical to slightly tapering rays, 0.16 to 0.31 mm. in diameter; stipe cylindrical, 0.42 to 0.59 mm. in diameter; rays of disc in contact with each other for most of their length.

Comparisons: *Clypeina pezanti* is distinguished from the other species of the genus discussed in this paper by its larger disc and very coarse rays.

Remarks: In the remarks under the species *Clypeina digitata* it was pointed out that *Dactylopora clypeina* is a senior synonym of *Clypeina pezanti*. However, use of that name is not permitted by Article 55 of the International Code of Botanical Nomenclature (Lanjouw, 1956), which states that specific names are illegitimate when they exactly repeat the generic name. The name *Clypeina marginoporella* is not available, as it was used by Michelin (1845) to designate a species from the Stampian of Morigny.

Clypeina infundibuliformis Morellet and Morellet, **emend.** Rezak

Plate 1, figures 2–3, 5, 7–12, 15, 17–18, 20

Clypeina marginoporella Michelin. – MORELLET AND MORELLET, 1913, Soc. Géol. France, Mém., vol. 21, fasc. 1, no. 47, p. 34, pl. 3, figs. 20–32.

Clypeina infundibuliformis MORELLET AND MORELLET, 1939, *Tertiary siphoneous Algae*, p. 11.

Emended description: Disc cup-shaped, 0.90 to 1.18 mm. in diameter, consisting of twelve to twenty-six cylindrical rays, 0.04 to 0.12 mm. in diameter; stipe cylindrical, 0.24 to 0.49 mm. in diameter; some fragments show two rings of ray bases (see pl. 1, fig. 12); distance between discs varies from 0.54 to 1.08 mm.; apex of stipe bears bases of up to sixteen sterile branches.

Comparisons: Clypeina infundibuliformis can be distinguished from *Clypeina pezanti* by its smaller disc and thinner rays, from *Clypeina johnsoni* n. sp. by its smaller disc, and from *Clypeina digitata* by the close contact of the rays of the disc throughout their length.

Remarks: The specimen illustrated by Applin and Applin (1944) in figure 13 of plate 2 belongs to this species.

Clypeina johnsoni Rezak, **new species**

Plate 1, figures 1, 6

Description: Disc cup-shaped, 1.18 to 1.56 mm. in diameter, consisting of sixteen to thirty cylindrical rays, 0.108 mm. in diameter; stipe cylindrical, 0.38 to 0.64 mm. in diameter; rays of disc in contact with each other throughout their length; apex of stipe bears bases of five or six sterile branches.

EXPLANATION OF PLATE 1

All figures × 10, in stereoscopic pairs.

1, 6 *Clypeina johnsoni* Rezak, n. sp.
1, apical view showing bases of fertile branches at periphery and parts of sterile branches at apex; U.S.G.S. Algae Coll. no. a611a20, Paleobotany Locality no. D612; 6, holotype, lateral view showing disc attached to stipe; U.S.G.S. Algae Coll. no. a611a35, Paleobotany Locality no. D612.

2–3, 5, 7–12, 15, 17–18, 20 *Clypeina infundibuliformis* Morellet and Morellet
2, apical view showing heavy calcification on rays of disc; numerous fine branches at apex are bases of sterile branches; U.S.G.S. Algae Coll. no. a611a17, Paleobotany Locality no. D612; 3, apical view showing numerous sterile branches; U.S.G.S. Algae Coll. no. a611a13, Paleobotany Locality no. D612; 5, basal view of disc showing place of attachment of disc to stipe; U.S.G.S. Algae Coll. no. a612a57, Paleobotany Locality no. D613; 7–8, oblique and apical views showing nature of disc; U.S.G.S. Algae Coll. no. a611a5, Paleobotany Locality no. D612; 9, fragments of two stipes, each having two fertile discs; the stipe on the right shows the base of a third disc, which has been lost; U.S.G.S. Algae Coll. no. a612b16, Paleobotany Locality no. D613; 10, weathered specimen having two discs in place; U.S.G.S. Algae Coll. no. a612a22, Paleobotany Locality no. D613; 11, basal view of a weathered disc showing molds of rays; parts of three rays are still preserved; U.S.G.S. Algae Coll. no. a612a7, Paleobotany Locality no. D613; 12, lateral view showing two rings of ray bases; U.S.G.S. Algae Coll. no. a612c33, Paleobotany Locality no. D613; 15, basal view showing the point of attachment of the rays of the disc; U.S.G.S. Algae Coll. no. a612c6, Paleobotany Locality no. D613; 17, oblique view of a heavily calcified specimen showing stipe extending through disc; U.S.G.S. Algae Coll. no. a612a45, Paleobotany Locality no. D613; 18, lateral view showing disc attached to stipe; U.S.G.S. Algae Coll. no. a611a36, Paleobotany Locality no. D612; 20, basal view showing molds of disc rays and stipe; U.S.G.S. Algae Coll. no. a612b36, Paleobotany Locality no. D613.

4, 16, 19 *Clypeina* sp.
4, apical view of a heavily calcified specimen; U.S.G.S. Algae Coll. no. a612a13, Paleobotany Locality no. D613; 16, apical view showing bases of many sterile branches; U.S.G.S. Algae Coll. no. a611a60, Paleobotany Locality no. D612; 19, fragment of a disc showing upper surface of flattened rays; U.S.G.S. Algae Coll. no. a612b38, Paleobotany Locality no. D613.

13 *Clypeina digitata* Morellet and Morellet
Apical view showing separated nature of tapering rays; U.S.G.S. Algae Coll. no. a612c25, Paleobotany Locality no. D613.

14 *Clypeina pezanti* Morellet and Morellet
Basal view showing flattened nature of disc; U.S.G.S. Algae Coll. no. a612b41, Paleobotany Locality no. D613.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Comparisons: This species can be distinguished from *Clypeina infundibuliformis* by its larger disc, and from *Clypeina pezanti* by the thinner rays of its disc.

Holotype: U.S.G.S. Algae Collection, no. a611a35.

Remarks: The species is named in honor of J. Harlan Johnson, who has pioneered in the study of North American fossil algae.

DISTRIBUTION AND CORRELATION

The Avon Park limestone underlies the Ocala limestone throughout much of Florida, being absent only in western Florida and a small area in Suwannee and Columbia Counties in northern Florida. Fragments of *Clypeina* are very abundant near the top of the formation over the area shown by the Applins (1944, p. 1686, text-fig. 3), and have been used to determine the upper limits of the formation when other fossils are lacking (Applin and Applin, 1944, p. 1687). According to the Applins (1944, p. 1686), the Avon Park is tentatively correlated with the Yegua formation (Claiborne) of the western Gulf Coast. The stratigraphic ranges of the species described by the Morellets (1939, pp. 11, 12) from the Paris Basin are as follows:

Clypeina infundibuliformis Morellet and Morellet: Lutetian and Auversian;

Clypeina digitata (Parker and Jones) (= *Clypeina stelliformis* Morellet and Morellet): Lutetian;

Clypeina pezanti Morellet and Morellet: Lutetian to Bartonian.

Specimens of *Clypeina infundibuliformis* and *Clypeina digitata* make up about 80 per cent of the known Avon Park flora. This furnishes additional evidence for assigning a Claiborne age to the unit.

BIBLIOGRAPHY

Applin, P. L., and Applin, E. R.
1944 – *Regional subsurface stratigraphy and structure of Florida and southern Georgia.* Amer. Assoc. Petr. Geol., Bull., vol. 28, pp. 1637–1753, pls. 1–5, text-figs. 1–38.

Carpenter, W. B., Parker, W. K., and Jones, T. R.
1862 – *Introduction to the study of foraminifera.* London: Ray Society.

Emberger, L.
1944 – *Les plantes fossiles dans leurs rapports avec les végétaux vivants.* Paris: Masson et Cie, 492 pp.

Gümbel, C. W.
1872 – *Die sogenannten Nulliporen; Zweiter Teil – Die Nulliporen des Tierreichs (Dactyloporideae).* K. Bayer. Akad. Wiss. München, Math.-Physik. Cl., Abh., vol. 11, pt. 1, pp. 229–290, pls. 1–4.

Lanjouw, J., and others
1956 – *International code of botanical nomenclature.* Utrecht, Netherlands: International Bureau for Plant Taxonomy and Nomenclature.

Michelin, H.
1845 – *Iconographie zoophytologique; Description par localités et terrains des polypiers fossiles de France et pays environnants.* Paris: P. Bertrand, livr. 16–20, pp. 161–221, pls. 45–46.

Morellet, L., and Morellet, J.
1913 – *Les Dasycladacées du Tertiaire parisien.* Soc. Géol. France, Mém., vol. 21, fasc. 1, no. 47, pp. 1–43, pls. 1–3.
1918 – *Observations sur le genre Clypeina Michelin.* Soc. Géol. France, Bull., vol. 18, no. 4, pp. 102–105.
1922 – *Nouvelle contribution à l'étude des Dasycladacées tertiaires.* Soc. Géol. France, Mém., vol. 25, fasc. 2, no. 58, pp. 1–35, pls. 1–2.
1939 – *Tertiary siphoneous algae in the W. K. Parker collection with descriptions of some Eocene Siphoneae from England.* London: British Museum (Natural History), pp. 1–55, pls. 1–6, text-figs. 1–7.

Munier-Chalmas, E.
1877 – *Observations sur les algues calcaires appartenant au groupe des Siphonées verticillées (Dasycladées Harv.) et confondues avec les foraminifères.* Acad. Sci., C. R., vol. 85, pp. 814–817, figs. 1–4.

Orbigny, A. D. d'
1850 – *Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnés, faisant suite au Cours élémentaire de paléontologie et de géologie stratigraphiques.* Paris: V. Masson, vol. 2, p. 397.

Parker, W. K., and Jones, T. R.
1860 – *On the nomenclature of the foraminifera; Part IV – The species enumerated by Lamarck (continued).* Ann. Mag. Nat. Hist., ser. 3, vol. 5, pp. 466–477.

Pia, J.
1927 – *Thallophyta.* In: Hirmer, M., *Handbuch der Palãobotanik.* Munich and Berlin: R. Oldenbourg, 708 pp.

Solms-Laubach, H.
1895 – *Monograph of the Acetabularieae.* Linn. Soc. London, Proc., ser. 2, vol. 5, pt. 1, pp. 1–39, pls. 1–4.

ABSTRACT: *The titles of 107 theses on ostracodes, many unpublished, are listed. The author, year of presentation, and university are given for each thesis.*

Bibliography of ostracode theses

LOUIS S. KORNICKER
Columbia University
New York

The following bibliography of theses pertaining to ostracodes was assembled from the "Bibliography of geology theses" compiled by Daniel S. Turner (1954) for the Petroleum Research Corporation's Micro-Research-Card Sedimentary and Petroleum Geology Library, and from "Dissertation Abstracts," published monthly by University Microfilms, Ann Arbor, Mich., up to and including volume 16, no. 12 (December, 1956). It contains the titles of 107 papers, many of which have not been published. It is believed that unpublished theses may contain valuable background material which will be useful to ostracode workers and graduate students. Some theses which have been subsequently published are also included in this list because it is not unusual for data to be omitted, for the sake of brevity, from the published paper. The list will also serve to indicate the university from which each thesis may be obtained, and the year in which it was submitted.

ALEXANDER, CHARLES I.
A preliminary study of the stratigraphic importance of the Ostracoda in the Fredericksburg and Washita formations of north Texas. M.S., 1926, Texas Christian University.

ANISGARD, HARRY W.
Ostracoda of the Vienna limestone. M.A., 1939, Columbia University.

AWBREY, ELIZABETH
A comparative study of species of the ostracode genus Cythereis of the Washita group in north Texas. M.S., 1939, University of Oklahoma.

BEACH, PAUL R.
Ostracodes of the family Bairdiidae from the Middle Permian Schwagerina crassitectoria zone of West Texas. A.M., 1952, Washington University.

BEAN, BERYL KENNETH
Ostracods of the Gimlet cyclothem (Pennsylvanian) near Peoria. M.S., 1938, University of Illinois.

BECKER, L. E.
Ostracodes from the Snyder Creek shale of Callaway and Montgomery Counties, Missouri. A.M., 1940, University of Missouri.

BENSON, RICHARD HALL
The ecology of the Recent ostracods of the Todos Santos Bay region, Baja California, Mexico. Ph.D., 1955, University of Illinois.

BERDAN, JEAN M.
Brachiopoda and Ostracoda of the Manlius group of New York State. Ph.D., 1949, Yale University.

BERNARD, HUGH ALLEN
Pleistocene Ostracoda and foraminifera of southwestern Louisiana. M.S., 1940, Louisiana State University.

BILLINGS, GLADYS D.
Pennsylvania Ostracoda of the Wayland shale of Texas. M.A., 1931, Columbia University.

BLAKE, DANIEL B.
Gosport Eocene Ostracoda from Little Stave Creek, Alabama. M.S., 1949, Louisiana State University.

BOGART, VERA JO
The paleoecology of the Ostracoda of the Corsicana marl at Onion Creek, Travis County, Texas. M.S., 1952, Columbia University.

BOOTH, ROBERT T.
Ostracoda of the Wayland shale member of the Graham formation, Pennsylvanian, Graham, Texas. M.A., 1932, Columbia University.

BORGER, HARVEY DANIEL
Ostracodes of the Macoupin cyclothem, Upper Pennsylvanian of southeastern Illinois. M.S., 1939, University of Illinois.

BRACKMIER, GLADYS H.
The ostracod genus Glyptopleura. M.A., 1930, Columbia University.

BROCKHOUSE, ROBERT B.
Ecology of marine Ostracoda. M.S., 1951, University of Illinois.

BROPHY, JOHN ALLEN
The stratigraphic range of some genera of the ostracod family Cytheridae. A.B. (High Honors), 1948, University of Illinois.

BROPHY, JOHN ALLEN
The ostracode genus Hollinella. M.S., 1949, University of Illinois.

BROUSSARD, MARION U.
Vanderpolia, a new genus of Ostracoda from the Gulf Coast of North America. M.S., 1932, Louisiana State University.

CAMPAU, DONALD E.
The stratigraphic distribution of Ostracoda within the Traverse formation of the Michigan Basin. M.S., 1950, Michigan State College.

CAMPBELL, A. RICHARD
Some ostracodes from the basal Ludlowville (Hamilton), Genesee County, New York. M.S., 1952, University of Rochester.

CARSOLA, A. J.
Depth distribution of Recent Ostracoda collected off Baja California. M.S., 1947, University of Southern California.

CHAMBERS, JACK
Ostracoda of the lower Jackson Eocene of Louisiana. M.S., 1935, Louisiana State University.

CORDELL, ROBERT J.
Ostracodes from the Trivoli cyclothem. M.S., 1940, University of Illinois.

CORDELL, ROBERT J.
Ostracodes from the Upper Pennsylvanian of Missouri. Ph.D., 1949, University of Missouri.

CRAMER, HOWARD ROSS
Studies of some Tertiary Ostracoda. B.S. (Honors), 1949, University of Illinois.

CRAMER, HOWARD R.
Tertiary fresh-water Ostracoda from the Uinta Basin, Utah. M.S., 1950, University of Illinois.

CRAWFORD, G. P.
Ostracode species from lower Glenrose formation of central Texas (C857). M.S., 1942, University of Texas.

CROUCH, R. W.
Pliocene Ostracoda from southern California. M.S., 1948, University of Southern California.

CUSKLEY, VIRGINIA A.
Some new ostracodes from the "White Mound" section, Haragan shale, Murray County, Oklahoma. M.A., 1932, Columbia University.

DAVIES, JAMES D.
Stratigraphy and ostracode distribution of the Cherokee and Henrietta formations of Randolph, Chariton, and Boone Counties. A.M., 1936, University of Missouri.

DILLINGHAM, HERVIE, JR.
Ostracoda of the Ostrea thirsae zone of the Nanafalia formation, Wilcox Eocene of Alabama. A.M., 1952, Washington University.

DRAKE, ROBERT T.
The relationships of the ostracode genus Schmidtella to Eridoconcha, with descriptions of new species of Schmidtella from the Bromide (Ordovician) of Oklahoma. A.M., 1939, University of Missouri.

FIELDS, SUZANNE
A Gatun ostracode fauna from Cativa, Panama. M.A., 1936, Columbia University.

FORD, GLEN M.
Some Pennsylvanian ostracodes from western Kentucky. M.S., 1941, University of Illinois.

FROST, VICTOR D.
Oligocene Ostracoda from the State of Mississippi. M.S., 1934, University of Oklahoma.

FUNKHOUSER, HAROLD J.
The Ostracoda of the Clore formation. M.S., 1938, University of Chicago.

GALE, ARTHUR S., JR.
Common Ostracoda of the Golconda formation. M.S., 1938, University of Chicago.

GEIS, HAROLD L.
Some ostracodes from the Salem limestone, Mississippian of Indiana. M.S., 1933, University of Illinois.

GILLESPIE, RUTH F.
Bartonian foraminifera and ostracods. M.A., 1930, Columbia University.

GOLLNICK, ROBERT L.
Phylogeny of the ostracode family Kirkbyidae with special reference to the genus Amphissites. M.S., 1941, University of Illinois.

GOOCH, DEE DAVID
Some ostracodes of the genus Cythereis from the Cook Mountain Eocene of Louisiana. M.S., 1939, Louisiana State University.

HAMILTON, IRVING S.
Ostracodes of the upper Atoka and Cherokee group of northeastern Oklahoma. M.S., 1941, University of Tulsa.

HANSEN, DONALD L.
Distribution of Ostracoda in the Decorah shale formation at St. Paul, Minnesota. M.S., 1951, University of Minnesota.

HENDERSON, JANET
Ostracod fauna of the Bell shale formation of Michigan. M.S., 1951, University of Michigan.

HENDRIX, WILLIAM E.
Ostracodes of the Olentangy shale of central Ohio. M.S., 1939, Ohio State University.

HENTON, JOHN M., JR.
North American Mesozoic and Cenozoic Ostracoda of the family Cytheridae. M.S., 1949, University of Illinois.

HOARE, RICHARD D.
The ostracode genus Metacypris in North America. M.A., 1953, University of Missouri.

HOLLAND, WILBUR C.
The ostracods of the Ninevah limestone of Pennsylvania and West Virginia. M.S., 1933, University of Pittsburgh.

HOPF, ROBERT W.
Ostracodes and age of the Welden and Sycamore limestones, Mississippian, of Oklahoma. A.M., 1942, University of Missouri.

JENNINGS, PHILLIP H.
Some ostracodes from the Morrison formation, Fall River County, South Dakota. M.A., 1934, Columbia University.

JOHNSON, SAMUEL C.
Ostracoda of the Clore limestone. M.A., 1938, Columbia University.

KEENAN, J. E.
Ostracodes from the Maquoketa shale of Missouri. A.M., 1940, University of Missouri.

KESLING, ROBERT V.
The morphology of ostracod molt stages. Ph.D., 1949, University of Illinois.

KILGORE, J. E.
Ostracods of the families Leperditellidae, Drepanellidae, Glyptopleuridae, Kloedenellidae, Bairdiidae, Barychilinidae and Thlipsuridae from the Genshaw formation of Michigan. M.S., 1951, University of Michigan.

KNIGHT, J. BROOKES
Some Pennsylvanian ostracodes from the Henrietta formation of eastern Missouri. M.A., 1928, University of Kansas.

KORNICKER, LOUIS S.
Quantitative distribution of ostracodes in the Florena shale (Permian) of Kansas. M.A., 1954, Columbia University.

KRAFT, JOHN CHRISTIAN
Morphologie and systematic relationships of some Middle Ordovician Ostracoda. Ph.D., 1955, University of Minnesota.

LEA, JOSEPH W.
The Ostracoda of the Red Bluff group of eastern Mississippi. M.S., 1936, Louisiana State University.

LEVINSON, STUART A.
The hingement of Paleozoic Ostracoda. A.M., 1949, Washington University.

LEVINSON, STUART A.
Studies on Paleozoic Ostracoda. Ph.D., 1951, Washington University.

LIVESAY, ELIZABETH A.
The ostracode family Cytheridae. B.S. (Highest Honors), 1944, University of Illinois.

LIVESAY, ELIZABETH A.
Study on Tertiary ostracods. M.S., 1945, University of Illinois.

LOONEY, HUGH M.
Ostracodes from the Bear River formation of southwestern Wyoming. M.A., 1948, University of Missouri.

LUCKHARDT, PAUL G. L.
New ostracodes from the Glen Dean formation. M.S., 1940, University of Chicago.

MALKIN, DORIS S.
Some ostracodes from the Widder beds of the Hamilton, at Rock Glen, near Arkona, Ontario. M.A., 1935, Columbia University.

MARPLE, MILDRED F.
Ostracodes from the Pottsville formation in Ohio. Ph.D., 1950, Ohio State University.

MARSH, MARION J.
Some foraminifera and Ostracoda from a coquina marl, Rosefield, Louisiana. M.A., 1944, Columbia University.

MARTIN, JAMES L.
Claiborne Eocene species of the ostracod genus Cytheropteron. M.S., 1939, Louisiana State University.

MAXEY, ROY
Permian Ostracoda from the Foraker to Herington formations of southern Kansas and northern Oklahoma. M.S., 1932, University of Oklahoma.

MCMILLAN, G. W.
Ostracods of the family Hollinidae from the Bell shale of Michigan. B.S., 1949, University of Michigan.

MILLS, LLOYD CLARENCE
Some Upper Eocene Ostracoda from the Conroe oil field, Montgomery County, Texas. M.A., 1936, University of Nebraska.

MOREY, P. S.
Ostracoda of the Sylamore sandstone of central Missouri. A.M., 1933, University of Missouri.

OLIVER, WILLIAM A., JR.
Hinge line structures of the ostracod family Cytheridae. B.S. (Honors), 1948, University of Illinois.

OSORIO, GUSTAVE A.
Pennsylvanian ostracodes from the Nowata shale. M.A., 1932, Columbia University.

PIETSCHKER, HAROLD L.
Saratoga Ostracoda from the type locality in southwestern Arkansas. M.S., 1952, University of Oklahoma.

PUNCHES, RICHARD K.
Ostracoda of the Golconda limestone. M.A., 1939, Columbia University.

RABBITT, JOHN C.
The Ostracoda of the Big Snowy group, Mississippian, of Montana. M.S., 1937, Montana School of Mines.

RALL, RAYMOND W.
Ostracoda from the depauperate zone of the Maquoketa shale. M.S., 1951, University of Illinois.

REIDER, EUGENE R.
Ostracoda of the Florena shale of Kansas. M.S., 1952, University of Nebraska.

ROBERTS, J. F.
Ostracoda from the Sundance (Jurassic) formation of central Wyoming. A.M., 1934, University of Missouri.

ROGATZ, HENRY
The ostracode fauna of the Arroyo formation, Wichita-Albany group of the Permian, in Tom Green County, Texas. M.A., 1932, Columbia University.

RUSSO, AMELIA GLORIA
The ostracod fauna of the Arkona shale, Arkona, Ontario. M.A., 1934, Columbia University.

SAMPLE, CHARLES H.
The ostracods of the East Mountain shale (Texas). M.A., 1932, Columbia University.

SAYYAB, ABDULLAH SHAKIR
Cretaceous Ostracoda from the Persian Gulf area. Ph.D., 1956, State University of Iowa.

SCHEIERN, MILTON R.
A study of species of the ostracod genus Dizygopleura from the Middle Devonian Traverse group of Michigan. M.S., 1953, University of Michigan.

SCHMIDT, RUTH A. M.
Miocene Ostracoda from the Yorktown formation, Virginia. M.A., 1939, Columbia University.

SCHMIDT, RUTH A. M.
Ostracoda from the Upper Cretaceous and Lower Eocene of Maryland, Delaware, and Virginia. Ph.D., 1948, Columbia University.

SEXTON, JAMES V.
The ostracode genus Cytherelloidea in North America. M.S., 1950, Louisiana State University.

SHAVER, ROBERT H.
The morphology, ontogeny, and classification of the ostracod families Bairdiidae, Cypridae, Cytherellidae, and Healdiidae. Ph.D., 1951, University of Illinois

SMITH, MARVIN
Ostracodes from Middle Devonian Ledyard, Wanakah, and Tichenor shales of western New York. M.S., 1952, University of Rochester.

SOHN, ISRAEL G.
Ostracoda from the Mauch Chunk (Mississippian of West Virginia). M.A., 1938, Columbia University.

SPIVEY, ROBERT C.
The ostracodes of the Maquoketa shale of Iowa. Ph.D., 1938, State University of Iowa.

STAPLIN, JOHN LYONS
Pleistocene Ostracoda of Illinois. Ph.D., 1953, University of Illinois.

STEWART, ROBERT H.
Some Hamilton ostracodes of western New York State. M.S., 1946, Northwestern University.

STILES, FRANCES M.
The brachiopods, trilobites and ostracods of the Ordovician strata of the Mingan Islands. B.A., 1933, University of Wisconsin.

TABOR, NORMAN R.
Ostracods of the family Hollinidae from the Genshaw formation of Michigan. M.S., 1951, University of Michigan.

TAYLOR, WILLIAM H.
Studies on Recent ostracodes in relation to the taxonomy of fossil ostracodes. A.M., 1931, Stanford University School of Mineral Sciences.

TEIS, M. R.
Pennsylvanian ostracods from the Brownwood shale of Wise County, Texas. M.S., 1931, University of Chicago.

THURMAN, FRANKLIN A.
The Ostracoda of the Kincaid formation. M.S., 1938, University of Chicago.

VITZ, HOWARD E.
Some Cretaceous ostracods from North and South Carolina. M.S., 1939, University of North Carolina.

WEINGEIST, LEO
The ostracode genus Eucytherura and its species from the Cretaceous and Tertiary of the Gulf Coast. M.S., 1948, Louisiana State University.

WEISS, MARTIN
Ostracod fauna of the Norway Point formation of Michigan. M.S., 1951, University of Michigan.

WEISS, MARTIN
Ostracods of the family Hollinidae from the Middle Devonian formations of Michigan and adjacent areas. Ph.D., 1954, University of Michigan.

WHITE, HAROLD R.
Eocene non-marine Ostracoda of Wyoming. M.S., 1948, University of Illinois.

WHITMORE, FRANK C., JR.
Upper Silurian ostracode faunas from Nearpass quarries, New Jersey. M.S., 1939, Pennsylvania State College.

WILLIAMSON, MARJORIE
A study of the Ostracoda fauna of the Waldron shale, Flat Rock Creek, St. Paul, Indiana. M.A., 1934, Columbia University.

ABSTRACT: *A method of treating fossil ostracode carapaces, causing them to open and release fragments of the chitinous integument, is described.*

A new method of recovering remains of the chitinous integument of fossil Ostracoda

GERALD P. R. MARTIN
c/o Wintershall Aktiengesellschaft
Barnstorf, Germany

The systematic classification of living ostracode species is based mainly upon differences between the various elements of the chitinous skeleton or integument of the animal, especially that of the extremities and their delicate processes, and upon the soft parts of the body. The shell and its properties are of much less importance in the determination of species. In contrast to this situation, the classification of fossil Ostracoda has had to be based upon the characters of the shell, such as shape and ornamentation, dentition, and number and form of muscle scars, because of the apparent absence of fossilized parts of the animal itself.

It has been known for many years, however, that the chitinous skeletons of fossil Arthropoda have very often been preserved over long periods of geologic time. Moreover, some workers have succeeded in recovering remains of the chitinous inner linings of the tests of foraminifera by dissolving the entire test. In view of these facts, it was only a short step to the idea that it might be possible to recover chitinous material from fossil ostracodes by similar treatment. But conditions did not generally seem to be very favorable for carrying out this idea, because in many cases the carapaces of fossil Ostracoda opened immediately after the death of the animal, each valve being buried separately, or the closed carapaces were crushed by pressure or were filled with completely opaque mineral matter, such as pyrite, or with clayey material that entered through the coarse openings of the shell or between the valves. Nevertheless, conditions of preservation were more or less favorable in certain strata, for example, in the Upper Permian, Liassic, Neocomian, Tertiary and other series. Here we have rather frequently found undamaged closed carapaces filled with translucent yellowish calcite, which appeared to be suitable for treatment. But, as far as it was possible to observe from the exterior, these glassy carapaces likewise did not seem to contain anything more than pyrite aggregates or shapeless clouds of darker material. The chitinous body parts appeared to have been dissolved away long ago.

However, as a result of the enthusiasm and perseverance of H. Gocht, of the micropaleontological laboratory of the Wintershall Aktiengesellschaft at Barnstorf, near Bremen, we have finally succeeded in recovering very well preserved chitinous parts of various ostracode genera from several geologic horizons. Gocht selected about 150 especially well preserved carapaces and treated them with a very weak solution of hydrochloric acid, observing the entire process of solution under the microscope. Very soon after he had put the ostracodes into the acid, the carapace opened and out of it came large, sometimes cohesive patches of chitinous material, apparently the "skin," or integument, of the animal. Some of these chitinous coatings were so well preserved that they clearly showed the extremities, with all their fine processes. We have tested the method several times, and it can be stated unequivocally that these remains undoubtedly came from the interior of the treated ostracode, and were by no means foreign organic material. Dr. F. Goerlich of the Deilmann Bergbau at Bentheim, with whom we consulted, has succeeded in confirming our results in every respect.

Gocht and Goerlich are publishing a note on the preliminary results of this method, which seems to hold great promise for future studies of the Ostracoda. The fact that about fifty out of the 150 carapaces treated produced chitinous material indicates that this method may eventually lead to a better classification of fossil Ostracoda, especially in re-

lation to Recent forms. The great bulk of the work still remains to be done—thousands of carapaces will have to be dissolved, and all the chitinous remains recovered will have to be carefully analyzed and compared with the organs of living species.

The successfully treated material came principally from Neocomian and Liassic beds in northern Germany, but ostracodes from other beds, for example, from the Zechstein (Upper Permian), have also been treated with success. On the other hand, it is a strange fact that none of the many carapaces of Wealden or Purbeck Cyprideidae treated produced any chitinous remains, and the same is true of *Protocythere propria, Cythereis senckenbergi*, and other sculptured forms. But there is no doubt that the carapaces of this formerly important extinct family, which are often very well preserved, as well as those of many other ostracodes, will some day be made to yield the remains of the chitinous integument, perhaps by the use of a different solvent, or to reveal them by means of infrared photography.

BIBLIOGRAPHY

GOCHT, H., AND GOERLICH, F.
[MS.] *Reste des Chitin-Skelettes in fossilen Ostracoden-Gehäusen.* Geol. Jahrb., Hannover, vol. 73 (in press).

ABSTRACT: *Charophytes in chert from New England stream beds help to identify the chert as fragments of old millstones made from the Oligocene Montmorency millstone of France.*

Charophyta-bearing chert from New England stream beds

WARREN I. JOHANSSON
University of Massachusetts
Amherst, Massachusetts

The purpose of the present note is to report the occurrence and to comment on the source of Charophyta-bearing chert found in two different stream beds in New England. These observations may be of interest, as further geological exploration may reveal chert of this type in many stream beds, both within and beyond the limits of New England.

Attention was first directed to the presence of Charophyta-bearing chert in Vermont during June, 1953, with the discovery of a subangular block of chert in the bed of Baker Brook in Williamsville. In addition to charophytes, the rock contains numerous molds and casts of gastropods. Chert is totally foreign to the area, and consequently a number of specimens were collected for examination.

The first thought concerning the origin of the chert block was that it represented a glacial erratic. An examination of the samples revealed several different non-marine Tertiary gastropods and numerous oogonia of *Chara medicaginula* Ad. Brongniart, 1822. (Grambast and Grambast (1954, p. 666) have transferred this species to the genus *Brachychara*.) This charophyte and the gastropods are not known in eastern North America, a fact which rules out a glacial-drift origin. Groves (1933, p. 25), in his catalogue of fossil Charophyta, lists *Chara medicaginula* as an exclusively European species. The problem was to determine the source of the chert and how it came to occur in the Vermont stream bed.

During Colonial times, chert was brought to this country from England as ship's ballast, and was then utilized in the manufacture of flints for flintlock rifles and other articles. Historical research indicates, however, that this type of chert was not used as flints.

A specimen of the Vermont chert was sent to Dr. F. W. Anderson of the Geological Survey and Museum in London for examination. Before his reply was received, Thomas Rice, of the Geology Department of the University of Massachusetts, recovered two more blocks of the same type of chert from the bed of the Westfield River in West Springfield, Massachusetts. The larger of the two blocks showed distinct grooves similar to those seen on millstones. As a result of this discovery, an investigation was made of the kinds and sources of millstones used in this area. Kuhlmann (1929), Rawson (1935), and van Wagenen (1953) indicate in their writings that some of the millstones were made from burrstone imported from Rouen and Bordeaux, France. Several local historians told the same story. The French burrstones are chert, and Rawson (1935, p. 138) states: "It is their roughness and toughness, resulting from their cellular structure due to the presence of fossil casts, which give them their preeminence." The smaller millstones measured approximately three and one-half feet in diameter and were generally polygonal in outline. Larger millstones, ranging up to approximately seven feet in diameter, consisted of solid polygonal cores to which irregular blocks of chert embedded in a plaster-like cement and bound by a steel hoop were added along the periphery.

During the Colonial days of the Seventeenth Century, American colonists used not only English burrstones made from the Millstone Grit, but also native rocks. The early settlers of the Connecticut Valley utilized Triassic arkose, which they called "quartz-shot stone." This was supplanted by granite, granite-gneiss and other types of native rock. In eastern New York State, the Esopus grit, called

TEXT-FIGURE 1

Chara (Brachychara) medicaginula from chert found in a Vermont stream bed: a, side view; b, summit view; both × ca. 40.

"'sopus stone," was commonly used, and in Pennsylvania the Pottsville conglomerate. Both native rocks and French burrstone were used until about 1870 to 1890, when steel rollers were introduced, replacing the old-fashioned millstones.

There is some difficulty in fixing the date when the first French burrstones reached America, but van Wagenen (1953, p. 137) states that it was at least one hundred and fifty years ago. Kuhlmann (1929, p. 14) reports that most Pennsylvania millers were using French burrstones by 1770. There is no doubt that French burrstones were used in mills throughout eastern North America, and, according to Rawson (1935, p. 137), they found their way to Arkansas by 1870.

A reply from Dr. Anderson regarding the chert sample submitted to him arrived about the time that the history of the American millstones had been concluded. He states that the sample is definitely Oligocene chert from the Paris Basin, and that it is precisely the same as the rock used for a short time in England for facing millstones.

An inspection of millstones in the possession of some Massachusetts collectors and antique dealers has revealed several French burrstones. Chert from millstones was compared with samples collected from the stream beds, and the common origin of the various rocks and millstones was established by the presence of fossil charophytes. There can be little doubt that the chert in the stream beds came from abandoned millstones which gradually broke up.

Comparison of the specimens illustrated in text-figure 1 a–b with drawings of *Chara [Brachychara] medicaginula* and of *Chara medicaginula* var. *minor* published by Dollfus and Fritel (1919, pp. 258–259) shows that the New England material is identical with those Charophyta from the Paris Basin. Dollfus and Fritel's figures illustrate specimens from the lower part of the Beauce limestone, called the Montmorency millstone. Gignoux (1955, pp. 483–484) treats the lower part of the Beauce limestone as the Étampes limestone, and the isolated decalcified remnants (chert) of the Étampes to the north of Paris, in the vicinity of Montmorency, are known as the Montmorency millstone. It was this rock that was used extensively for millstones. Some of it was brought to North America for this purpose, and eventually found its way into stream beds as fragments.

BIBLIOGRAPHY

DOLLFUS, G. F., AND FRITEL, P. H.
1919 – *Catalogue raisonné des characées fossiles du Bassin de Paris.* Soc. Géol. France, Bull., ser. 4, vol. 19, pp. 243–261, text-figs. 1–23, table 1.

GIGNOUX, M.
1955 – *Stratigraphic geology.* San Francisco: W. H. Freeman and Company, pp. i–xvi, 1–682, text-figs. 1–154.

GRAMBAST, L., AND GRAMBAST, N.
1953 – *Revision de quelques charophytes tertiaires du Bassin de Paris.* Soc. Géol. France, C. R. Somm., no. 14, pp. 289–291.
1954 – *Sur la position systématique de quelques charophytes tertiaires.* Rev. Gén. Bot., vol. 61, pp. 665–671, text-fig. 1.

GROVES, J.
1933 – *Charophyta.* In: JONGMANS, W. (ed.), Fossilium Catalogus, II (Plantae), fasc. 19, pp. 1–74.

HORN AF RANTZIEN, H.
1956 – *An annotated check-list of genera of fossil Charophyta.* Micropaleontology, vol. 2, no. 3, pp. 243–256.

KUHLMANN, C. B.
1929 – *Flour milling industry in the United States.* Boston: Houghton Mifflin Company, pp. i–xvii, 1–349.

RAWSON, M. N.
1935 – *Little old mills.* New York: E. P. Dutton and Co., Inc., pp. 1–367, pls. 1–138.

WAGENEN, J. VAN
1953 – *The golden age of homespun.* Ithaca, N. Y.: Cornel University Press, pp. i–xviii, 1–280, text-figs. 1–45

The "Zoological Record"

ROBERT H. CUMMINGS
University of Glasgow
Scotland

The object of the "Zoological Record" is to present, in an annual volume, complete lists of the works and publications relating to zoology in all its branches, including palaeontology, that have appeared during the year preceding the issue of the volume, together with a subject and systematic index. For the past ninety years it has provided a constant source of reference for all groups of animals, both living and fossil. Its format permits rapid listing of the most recent scientific papers, not only those dealing with a particular taxonomic group but also with any aspect of zoology or palaeontology.

The present rapid expansion of micropaleontological research, and the recording of fossil representatives of such protozoan groups as the Chrysomonadida, Dinoflagellata, and Oligotrichida, as well as the continued appearance of large numbers of works dealing with the foraminifera, Heliozoa, and Radiolaria, have led to a great increase in the work of preparing the Protozoa Section of the Record. It is estimated that the present coverage of paleontological literature on fossil protozoans is in the neighbourhood of 80 per cent of the world output, and every effort is being made to improve this figure. To do so requires the cooperation of research workers in all parts of the world, and hence this appeal for assistance.

Coverage is incomplete for two reasons. Certain publications appear in scientific periodicals not available in this country because they are not catalogued in the World List, etc., and hence are unknown in British libraries. Secondly, the delivery of some scientific journals is often subjected to long delays, and this means that papers included in them are not listed in the volume for the year of their publication, but often appear some two or three years later. These difficulties could be overcome to some extent if research workers in other countries would notify us of omissions from the Record as it is published, or, alternatively, would advise us of their own publications or of those of associates when they are about to appear.

I hasten to add that many world experts already actively cooperate in the complication of the "Zoological Record," and I should like to acknowledge the assistance of such authorities as Dr. Hans Thalmann, Dr. A. R. Loeblich, Dr. Heinrich Hiltermann, and Dr. Brooks F. Ellis. A further valuable aid is found in the news reports of the correspondents in "Micropaleontology."

Correspondence concerning the "Zoological Record" may be addressed to: The Editor of the Zoological Record, Zoological Society of London, Regent's Park, London, N.W. 8., or, in the case of the Protozoa Section, to: Dr. Robert H. Cummings, Department of Geology, The University, Glasgow, W. 2, Scotland.

news reports

GERMANY

HEINRICH HILTERMANN

Rudolf Richter, the distinguished German paleontologist, died on January 5, 1957. The reknown that he gained in the field of paleontology, and his relationships with micropaleontology, have been indicated in detail in a previous issue of this publication (Hiltermann, 1957, Micropaleontology, vol. 3, no. 2, p. 192).

Again in 1956, stratigraphy occupied top rank in our work, as will be shown in the bibliography of micropaleontology in Germany for the year 1956, which comprises 106 entries and which will be published in the next issue of "Micropaleontology." Microfossils were used for stratigraphic purposes from the Silurian-Devonian boundary to Recent sediments. In this connection, several comprehensive taxonomic papers were published. Potonié and Kremp published a three-part monograph on sporae dispersae in the Carboniferous of the Ruhr Basin, and K. J. Müller wrote a paper on the Devonian conodont genus *Palmatolepis*. Papers with emphasis on stratigraphy based on Devonian conodonts were also published by B. Bischoff and W. Ziegler. A brief text-book of micropaleontology was published by H. W. Matthes. A review of recent microstratigraphic findings with reference to the Upper Cretaceous was presented in a special volume entitled "Upper Cretaceous," published as a supplement to volume 30 of the Paläontologische Zeitschrift.

A number of German micropaleontologists, especially those working in petroleum geology, were invited by our British colleagues Dr. Tom Barnard and F. W. Anderson to visit the classic sections on the Isle of Wight and the Dorset coast. The series of samples collected on this occasion, as well as the accompanying discussions, will be of great importance in future studies of Cretaceous and Jurassic stratigraphy. We take this opportunity to thank our English colleagues for our kind reception and for the ably conducted excursion.

Two of the so-called "Austauschsitzungen für Mikropaläontologie und Stratigraphie" (meetings for the exchange of results in micropaleontology and stratigraphy) were held during the past year at the Amt für Bodenforschung, Hannover. They were as follows:

Meeting 80: March 22, 1956. Two subjects were considered:

1) H. Hiltermann spoke on working methods in micropaleontology, on the basis of what he had learned during his trip to the United States;

2) The Arbeits-Ausschuß discussed the possibilities of classification of the upper Malm on the basis of micropaleontology.

Meeting 81: June 28, 1956. J. H. Ziegler spoke on "Mikrofaunistische Gliederung des Braunjura in Franken."

The annual meeting of the Paläontologische Gesellschaft took place in Wilhelmshaven August 12 to August 18, 1956. The research institute for marine geology and biology "Senckenberg am Meer" was host. Dr. J. J. Galloway was unanimously elected to honorary membership in the Paleontological Society, in recognition of his outstanding contributions to the development of micropaleontology, especially his research on foraminifera. Among the thirty-three papers delivered, eleven were concerned with micropaleontology: F. Bettenstaedt, "Microstratigraphy of Cretaceous sediments and tectonic units in the Helvetian and Flysch of the Bavarian and Vorarlberg Alps"; H. Beckmann, "Biometric methods in invertebrate paleontology"; G. von der Brelie, "Significance of phytoplankton, especially diatoms, in stratigraphy"; K. Diebel, "Occurrence of conodonts in the African Cretaceous"; S. J. Dijkstra, "Discovery of Lower Carboniferous megaspores"; K. Mädler, "Significance of charophyte oogonia in paleobotany and phylogeny"; P. Piewart, "Megaspores from the Belgian Westphalian C"; R. Potonié, "Synopsis of the species of sporae dispersae"; W. Remy, "Carboniferous microspores from fructifications of ferns"; J. H. van Voorthuysen, "Marine microstratigraphy of the Quaternary in the Netherlands"; and O. Wetzel, "Problematic microfossils from Upper Cretaceous chert."

At the meeting of the Deutsche Geologische Gesellschaft in Hannover in October, 1956, two papers and one field trip were concerned with micropaleontology. M.R. Sahni of Calcutta read a paper on recent research in paleontology in India, and H. Gerth of Bonn spoke on *Fusulina* limestones in the Patagonian Archipelago. The field trip was led by H. Hiltermann, and covered the Lower and Upper Cretaceous outcrops of Moorberg, Gleidingen, and Misburg, south and east of Hannover.

HEINRICH HILTERMANN
Amt für Bodenforschung
Hannover

JAPAN

KIYOSHI ASANO

Micropaleontological studies in Japan are gradually increasing, and in addition to foraminifera, research on pollen, Radiolaria, diatoms, calcareous algae, fish otoliths and fish scales is in progress. On the occasion of the annual meeting of the Geological Society of Japan, held April 6–9, 1957, in Tokyo, about ten papers in the field of micropaleontology were read. The current activities in the various institutions are described in detail below:

Tohoku University

Professor Hanzawa's beautiful monograph on the foraminifera of the South Sea Islands, published in Memoir 66 of the Geological Society of America, has just arrived. This work greatly expands our knowledge of the larger foraminifera of that region. Professor Hanzawa is now concentrating on the microfacies of the foraminiferous rocks of Japan and the nearby islands.

Professor Asano has just published his third report on the foraminifera obtained by the S. S. Soyo-maru. This report deals with the planktonic forms, and was published in the Science Reports of Tohoku University, series 2 (Geology), volume 28. Professor Asano is now working on the Buliminidae and Nonionidae, upon which he expects to report in a later number of the same journal. His study of the Paleogene foraminifera of Japan is also nearing completion.

Y. Takayanagi is now studying the Cretaceous foraminifera of Hokkaido, and, together with Professor Asano, has undertaken a biostratigraphic study of the Boso Peninsula, Chiba Prefecture. This work is still being continued.

After his return from abroad in September, 1956, T. Kanaya published an article on the Eocene diatoms of California, a result of his research at Stanford University. This paper appeared in the Science Reports of Tohoku University, series 2 (Geology), volume 28. T. Shibata has been studying Pliocene pollens for several years, but the results of his work have not yet been published.

Professor K. Hatai has published a paper on the Pliocene fish otoliths of the Boso Peninsula, Chiba Prefecture, and has numerous fossils awaiting description. He is also concentrating on accumulating Recent material for comparison with the fossil fish-scale specimens in his collection.

Shokei Women's College (Sendai)

M. Shimada has published several papers on Pliocene pollens from Yāmagata and Miyagi Prefectures. His work is being continued. His papers have appeared in the Science Reports of Tokyo University, series 4 (Biology), in the Ecological Review, and in the Sixtieth Anniversary Memorial Essays of the Foundation of Shokei Girls School.

Tokyo University of Education

H. Igo has published several papers on Permian fusulinids in the Science Reports of the Tokyo Kyoiku Daigaku, section C (Geology, Mineralogy and Geography). His recent monographic work on the fusulinids of the Paleozoic Hida Massif is now in press.

Y. Fujita is now making a statistical study of the Pliocene foraminifera of the Boso and Miura Peninsulas for comparison with Recent forms of the same genera and species, the results of which he expects to apply to the ecological factors governing the deposition of strata developed in other parts of Japan. H. Ujiie has completed his studies on the peculiar foraminiferal fauna dredged from Arari Bay, Izu Peninsula, Shizuoka Prefecture, and the manuscript is ready for publication. He is also advancing his studies on the internal structures of certain forms.

Professor Fujimoto has described a peculiar fusulinid from the Kitakami Massif of Miyagi Prefecture, and, together with S. Kawada, has described a new genus, *Hayasakaina*, from the Omi limestone of Niigata Prefecture. He expects to retire from his present position in March, 1958, after which he hopes to write on the material he has collected during the past thirty years.

Saitama University

Professor Endo reports that his duties as President of the University have seriously interfered with his scientific work. However, he attended the International Geological Congress held in Mexico, and his studies on the calcareous algae, chiefly of the Paleozoic formations of the Kitakami Massif in northern Japan, are making some progress.

Assistant Professor Morikawa has published a monograph on the Schwagerininae of the Kwanto Massif in central Japan. This work appeared in the Science Reports of Saitama University, series B, volume 2, number 1.

Hokkaido Gakugei University

K. Oshite has described diatoms from the oil shale (Miocene) developed in southwestern Hokkaido. S. Sakagami has described fusulinids from the southern part of Tokyo Prefecture in two papers, the second of which is now in press.

Kyoto University

Professor Makiyama, together with several students from his department, is now making a biostratigraphic study of the Kakegawa Tertiary in Shizuoka Prefecture, as related to sedimentation. We are all waiting for his results to be published.

Kyoto University of Textile Fibers

H. Okuno has just published the results of an electron-microscope study of the structure of fossil diatoms.

Osaka University of Liberal Arts and Education

N. Yamagiwa has published a report on Neoschwagerininae from the Shima Peninsula of Japan.

Kyushu University

Professor R. Toriyama is continuing his studies on the fusulinids of the Akiyoshi limestone. Assistant Professor T. Kanmera has published a paper on the evolution of the Schwagerininae and is continuing his research on the Fusulinidae of Kyushu. K. Takahashi's first report on pollen and biostratigraphy appeared in the Science Reports of Kyushu University, and his second and third reports are expected to be published this year.

Hiroshima University

Y. Tai has just published the results of a micropaleontological study of the Neogene deposits of Setouchi and San-in districts, and is now concentrating on the paleogeography of the same districts. His work was published in the Science Reports of Hiroshima University.

Osaka University

K. Nakaseko is now studying Neogene Radiolaria from Yamagata and Akita Prefectures, and comparing them with the Recent fauna of the Japan Sea. The results are expected to be published in the near future.

Geological Survey of Japan

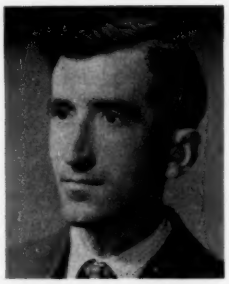
S. Tokunaga has been studying fossil pollen for several years and has published a number of papers in the Reports of the Geological Survey of Japan. His work has been confined to the oil fields and coal fields of Yamagata and Fukushima Prefectures.

Other news

Dr. T. Oinomikado and Dr. Leo Stach are now with the Chinese Petroleum Corporation of Taiwan, which is engaged in the exploitation of petroleum in Taiwan. They were sent to Taiwan at the request of UNESCO.

KIYOSHI ASANO
Institute of Geology and Paleontology
Tohoku University, Sendai

NORTH AFRICA



JEAN MAGNÉ

MOROCCO

Société Chérifienne des Pétroles (S.C.P.)

During 1956, the activities of the geological laboratory at Petitjean were concerned mainly with the examination of well and field samples from the Petitjean area, Mogador and Agadir. About 7600 thin sections and 2460 washed samples were studied. Ecologic studies of foraminifera, undertaken in order to determine precisely the conditions of sedimentation of the clays of the Lower Miocene, were continued. In addition to the routine work of drilling supervision, the laboratory also studied facies and microfaunas from the Sous Valley (Agadir) and the Mogador area. It appears that the microfaunas of the Lower Cretaceous are equivalent to those of Texas.

A revision of the genus *Globorotalia* based on species from northern Morocco was completed by J. Aubert and will be published soon. M. Rey, who occupied the post of chief of the laboratory for many years, has left the S.C.P. and is now working in France as an expert for the Société Nationale des Pétroles d'Aquitaine, at Pau. He has been replaced at Petitjean by P. L. Allard. J. Duchene has also left his position at the laboratory to work in France for the Société des Pétroles de Valence.

ALGERIA

University of Algiers

Under the guidance of Professor R. Laffitte and Professor Gabriel Lucas, research work in the geological laboratories of the university has been concerned with various problems of micropaleontology and petrography, particularly in connection with the study of environments of deposition, ecology and stratigraphy. Miss Claudine Bernard is continuing her work on the Cretaceous Radiolaria of Algeria. Georges Busson has carried on extensive studies of Upper Jurassic formations in the district of Tiaret, Department of Oran, where the discovery of rich beds of ammonites has enabled him, in collaboration with W. J. Arkell, to draw up a stratigraphic scale on an accurate basis. He is now attempting, in collaboration with J. Magné, to solve further problems in the stratigraphy of the Cretaceous, Eocene, and Miocene of the mountain mass north of the Chelif by the application of micropaleontology.

By means of a technique which he has perfected, Jacques Emberger has succeeded in completely freeing Jurassic and Neocomian tintinnids from their sediments, and is now carrying out a morphologic study based on comparisons with modern forms. He is also doing research on fossil Chlorophyceae, and is engaged in studies of the green algae of the Mesozoic of Algeria and of the Permian of southern Tunisia.

Mrs. Georgette Glaçon has just finished studies of the Miocene of the Ampère area and of the Eocene of Gergour, in the Department of Constantine. In close connection with Professor Lucas' research, she is completing a paper on Recent foraminifera of the Tunisian coastal area from the Gulf of Gabès to Tripolitania. This publication will include descriptions of living forms, with statistical distribution and biometrics.

Professor Lucas is continuing his research along the lines indicated by his doctoral dissertation, presented in 1942. He is now seeking to clarify the relationships between the petrographic characters of rocks and their conditions of sedimentation, particularly with regard to the nodular calcareous rocks known as "ammonotico rosso." In the course of his study of present-day marine sediments, he has discovered Recent

oolites at Djerba, southern Tunisia. He is planning to publish a general survey of the problems of petrographic facies of subreefal limestones, whether oolitic or not.

Pierre Muraour has completed a study of a Recent marine microfauna from the Algiers area. In collaboration with G. Colom, of Mallorca, he has also published a paper on marine foraminifera from the Miocene of the Basse Kabylie.

Miss Denise Noël is pursuing the study of coccolithophorids which she began some years ago in this laboratory. This group, often neglected by micropaleontologists, seems to have been of some importance as early as the Mesozoic. A paper was published during the past year on the Jurassic coccoliths of Algeria. The examination of the tests of certain species of fossil tintinnids has shown that they had agglutinated numerous coccoliths.

André Rosfelder is continuing his study of sediments of the continental border of Algeria. He is directing his work most particularly toward granulometric statistics, using new techniques. The numerous foraminifera which he has collected will be studied by J. Magné.

Compagnie Française des Pétroles (Algérie) — C. F. P. (A.)

The activity of the stratigraphic laboratory of the C.F.P.(A.) was extended in 1956 to cover all stratigraphic problems of the western Sahara. Professor Jean Cuvillier is the scientific consultant of the laboratory. Several staff changes took place during the past year. A. Fediaevsky was transferred to Paris in another branch of the C.F.P., and has been replaced here by Miss Janik Thibaut. Jean Thouvenin also began work in the laboratory in the fall of 1956.

Because of the diversity of the problems, the work of the staff has been divided as follows: V. Sacal, chief of the laboratory, examines samples from the Paleozoic, and has undertaken a revision of the stratigraphy. The laboratory already possesses a large collection of Paleozoic samples from the western Sahara, including about 12,000 field samples and more than 20,000 thin sections, and a photographic card index of microfacies. Miss Thibaut is interested mainly in problems concerning the Mesozoic. During the past year, she completed her work on the stratigraphy of the Mesozoic. Mr. Thouvenin has begun a detailed study of Triassic sandstones, a petrographic and stratigraphic problem which is very important from the point of view of oil geology.

Compagnie des Pétroles d'Algérie (C.P.A., Shell)

During 1956, the paleontological laboratory of the C.P.A., under the direction of M. Millioud, who is assisted by L. Nijssen, concentrated its activities mainly on problems of the Paleozoic. Good stratigraphic results were obtained by macropaleontological and palynological methods, particularly when they were used in combination. Palynology proved to be very useful in well correlation, especially in the Carboniferous. It was found that, in large areas of the Algerian Sahara, the upper part of what was formerly attributed to the Visean belongs to the Namurian. It is possible that in certain regions a stratigraphic break exists between the Devonian and the Carboniferous, comprising the lower part or the whole of the Tournaisian.

Société Nationale de Recherche et d'Exploitation des Pétroles en Algérie (S.N.REPAL)

During 1956, the central geological laboratory of S.N.REPAL, under the direction of Jean Magné, carried on a study of sediments from surface exposures and wells in northern Africa and the Sahara. The staff of the laboratory consists of three laboratory geologists, one assistant, one photographer, two secretaries, one illustrator, and eight laboratory helpers. About 3700 washed samples and more than 5000 thin sections were prepared and examined. A large number of photomicrographs were also made, forming the basis of several card indexes.

Micropaleontological research was concerned mainly with foraminifera, ostracodes, eopteropods, and charophytes. The study of microfacies and heavy minerals also produced interesting results. By means of rapid methods of embedding in resins or plastic materials, it has been possible to study well cuttings in thin section. These sections were previously very difficult to prepare, because of the delicacy of the material. These methods, first discovered by Claude Tempère, have been improved by Miss Simone Chastanier.

In spite of the large amount of time consumed by routine work, some interesting research projects have been carried out. Mr. Magné continued his detailed studies of the smaller pelagic foraminifera of the Algerian Tertiary. Between other papers, he is preparing, in collaboration with Dr. C. W. Drooger of Utrecht, a comparative study of Upper Oligocene and Lower Miocene horizons bearing rich planktonic microfaunas with those of the same age that are rich in miogypsinids. The Tertiary foraminifera of the Ouarsenis Range have also been studied in detail. In collaboration with V. Apostolescu, Mr. Magné has published a paper on new species of Ostracoda from the upper Lutetian of Algeria. He has also continued his work on the sedimentary petrography and microfossils of the Jurassic. The sediments of this period have been studied mainly from the regions of the Hauts Plateaux Oranais (Monts de Saida, de Daia, et de Tiaret), of the western Saharan Atlas, and of the Bas Sahara. In the latter broad area, numerous wells have made it possible to study the extension of the Jurassic, which was not previously known there. Interesting horizons in the Saharan Malm, containing charophytes and Ostracoda, will be studied in detail during 1957.

Mr. Magné has also studied the Cretaceous, mainly in the Saharan Atlas (Monts des Ouled Nail) and in the Hauts Plateaux Oranais. Horizons with charophytes (*Atopochara trivolvis* Peck and other species) discovered in the Aptian of the latter area will be described shortly in a publication with J. Emberger. The

Cretaceous of the Sahara has been studied in numerous wells, and has shown a high frequency of littoral facies. Horizons containing many species of *Schackoina*, discovered in the Lower Cretaceous of the Biban Range in northern Algeria, will be described in collaboration with J. Sigal, of the I.F.P. (Paris).

Claude Tempère and Miss Simone Chastanier have completed a study of the microstratigraphy of the Siluro-Devonian of the Sahara. In connection with this important project, they have carried out a revision of the microfacies and microfauna, and have attempted to work out the paleogeography. The area covered extends to the north edge of the Hoggar. A systematic study of Carboniferous microfaunas, based on thin sections, has been undertaken by Mr. Tempère. Miss Chastanier has been working mainly on Ostracoda and eopteropods, and has established their stratigraphic value.

The Triassic of the Sahara, discovered in wells, has been studied in detail for the first time. This research, undertaken by Miss Chastanier, will be pursued vigorously during the coming year. Until the present time, these formations, in the Algerian territories, have not yielded microfaunas. They are of great interest from the point of view of oil geology, petrography, and sedimentology.

In May, 1956, Mr. Tempère attended the international meeting on sedimentology held at Marseille and Nice. In July, Mr. Magné participated in the sessions of the geological and micropaleontological section of the A.F.A.S., whose annual meeting took place in Dijon. In September, Mr. Magné and Miss Chastanier attended the international symposium on micropaleontology, which met this year in London and visited the Isle of Wight and the Dorset coast.

During 1956, the activities of the S.N.REPAL field laboratory in Oued Djenan, near Sidi Aïssa, completely ceased.

Service de l'Hydraulique et Equipement Rural, Birmandreis (Alger)

Miss Claude Pinar has replaced Miss J. Thibaut, who has been engaged by C.F.P.(A.). During 1956, the new micropaleontologist worked on well and surface samples, mainly from the Cretaceous and Tertiary, collected by the geologists of the Survey in northern Algeria and the Sahara. In September, Miss Pinar attended the international symposium on micropaleontology in England.

TUNISIA

Société de Recherche et d'Exploitation des Pétroles en Tunisie (S.E.R.E.P.T.)

During 1956, micropaleontological work in the laboratory of this company was carried on by Charles Glintzboeckel. He was joined in May by J. Rabate, who had spent the first quarter of the year in studying the fusulinids under the direction of Professor R. Ciry in the laboratory of the Faculté des Sciences of Dijon.

The study of the Upper Cretaceous beds containing pelagic foraminifera (*Globotruncana*, *Thalmanninella*, *Rotalipora*, etc.) has been completed. At the beginning of the year, however, the laboratory staff was still studying Cretaceous horizons, but in this case the subreefal facies. The microfauna of the latter consists mainly of Ostracoda, *Cuneolina*, *Dicyclina*, *Valvulammina picardi* Henson, algae, and also, in the Cenomanian, forms resembling "*Cosinella*." Most recently, a study of upper Senonian beds with *Orbitoides* and *Siderolites* has been begun. This will constitute the last phase of research on the Cretaceous in this laboratory.

The micropaleontologists are working at present on older horizons: Jurassic beds with abundant trocholines in the upper part, and Triassic beds with interesting microfacies, as well as Upper Paleozoic. The very thick Upper Permian section has yielded an exceedingly interesting microfauna containing fusulinids (*Yabeina*, *Neoschwagerina*, *Dunbarula*, *Polydiexodina*, and *Parafusulina*), smaller foraminifera (*Hemigordius*, *Hemigordiopsis*, *Lasciodiscus*, *Lasciotrochus*, *Geinitzina*, *Globivalvulina*, *Nodosaria*, *Climacammina*, *Palaeotextularia*, *Endothyra*, *Tetrataxis*, *Cornuspira*, as well as some genera which appear to be new), Ostracoda, algae, and other microfossils. In the Djeffara area, the Lower Permian and Carboniferous, which it has been possible to date by means of fusulinids (*Pseudoschwagerina*, *Triticites*, *Pseudostaffella*, *Fusulina*), also contain smaller foraminifera (*Bradyina*, *Climacammina*, *Palaeotextularia*), Ostracoda, algae, and other microfossils.

In these studies, the usual methods have been applied. The very useful method of employing acetic acid to disengage microfossils from limestones has produced good results. The systematic examination of polished surfaces has also proven very useful, and expedites the study of microfossils in poor samples or in oriented sections in richer samples. A card index of the microfacies of Tunisia was also established in this laboratory during 1956.

Compagnie des Pétroles de Tunisie (C.P.D.T.)

At the laboratory of the C.P.D.T., Mr. Ford was engaged in the study of well samples until his departure from Tunisia. In May, 1956, the activities of this company ceased.

JEAN MAGNÉ
Laboratoire de Geologie
S.N.REPAL
Oued Smar, Algeria